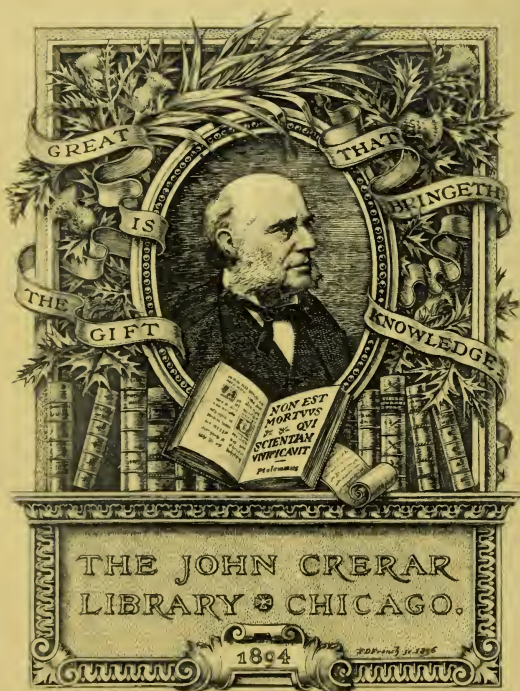




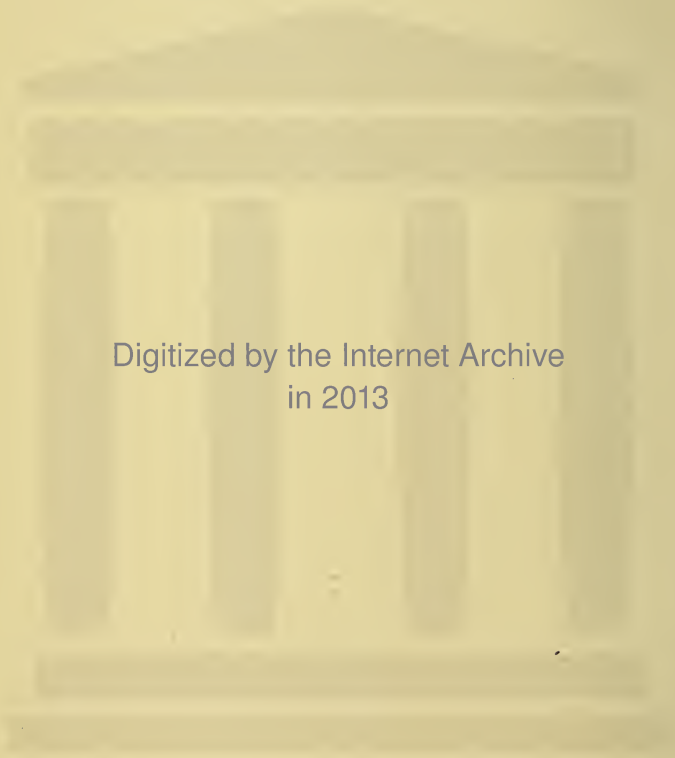
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UNIVERSITY OF
PITTSBURGH
BULLETIN
SCHOOL OF MINES
EDITION



ANNOUNCEMENT
FOR 1911—1912

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UNIVERSITY OF
PITTSBURGH
BULLETIN

SCHOOL OF MINES
EDITION



ANNOUNCEMENTS
FOR 1911—1912

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SCHOOL OF MINES CALENDAR

1910-1911

September 22-24.....	Thursday to Saturday—Registration, Examination for admission.
September 26.....	Monday—Work began.
October 10.....	Monday—Fall Meeting, Board of Trustees.
November 24-26.....	Thursday to Saturday—Thanksgiving recess.
December 12.....	Monday—Winter Meeting, Board of Trustees.
December 17.....	Saturday—Fall Term closed.
December 19.....	Monday—Vacation of two weeks began.

1911

January 3.....	Tuesday—Winter Term, twelve weeks, began. Work resumed.
February 9.....	Thursday—Day of Prayer for Colleges.
February 22.....	Wednesday—Washington's Birthday, a holiday.
February 28.....	Tuesday—Charter Day.
March 13.....	Monday—Spring Meeting, Board of Trustees.
March 25.....	Saturday—Winter Term ended.
March 27.....	Monday—Spring vacation of one week began.
April 3.....	Monday—Spring Term of eleven weeks, began.
April 14.....	Friday—Good Friday, a holiday.

May 30.....	Tuesday—Decoration Day, a holiday.
June 11.....	Sunday—Baccalaureate Sermon.
June 12.....	Monday—Annual Meeting, Board of Trustees.
June 14.....	Wednesday—Commencement.
June 15-17.....	Thursday to Saturday—Registration and examinations for admission.
June 17.....	Saturday—Spring Term ends.

1911-1912

June 26.....	Monday—Summer Term of ten weeks begins, 8 A. M.
September 2.....	Saturday—Summer Term ends.
September 21-23.....	Thursday to Saturday—Registration and examinations for admission.
September 25.....	Monday—Work begins at 8 A. M.
October 9.....	Monday—Fall Meeting, Board of Trustees.
November 30.....	Thursday to Saturday—Thanksgiving recess.
December 11.....	Monday—Winter Meeting, Board of Trustees.
December 16.....	Saturday—Fall Term closes.
December 18.....	Monday—Vacation of two weeks begins.

1912

January 2.....	Tuesday—Winter Term, twelve weeks, begins. Work resumed at 8 A. M.
February 8.....	Thursday—Day of Prayer for Colleges.

February 22.....	Thursday—Washington's Birthday, a holiday.
February 28.....	Wednesday—Charter Day. One hundred twenty-fifth Anniversary of the University.
March 11.....	Monday—Spring Meeting, Board of Trustees.
March 23.....	Saturday—Winter Term ends.
March 25.....	Monday—Spring vacation of one week begins.
April 1.....	Monday—Spring Term of eleven weeks begins at 8 A. M.
April 5.....	Friday—Good Friday, a holiday.
May 30.....	Thursday—Decoration Day, a holiday.
June 9.....	Sunday—Baccalaureate Sermon.
June 10.....	Monday—Annual Meeting, Board of Trustees.
June 12.....	Wednesday—Commencement.

1912

June 13-15.....	Thursday to Saturday—Registration and examinations for admission.
June 15.....	Saturday—Spring Term ends.
June 24.....	Monday—Summer Term of ten weeks begins.
August 31.....	Saturday—Summer Term ends.
September 19-21.....	Thursday to Saturday—Registration and examinations for admission.
September 23.....	Monday—Work begins at 8 A. M.

STATE HALL, THE SCHOOL OF MINES BUILDING

is located at the corner of Grant Boulevard, Bayard Street and Parkman Avenue, opposite the Soldiers' Memorial. It is about one block northward from Schenley Hotel, Pittsburgh Athletic Association Building, and the University Club, two squares northwardly from Forbes Field, four from the Carnegie Museum and Library, and about six blocks from the Carnegie Technical Schools.

Offices, State Hall, the School of Mines Building; Telephone Schenley, 2500.

Business Office No. 106.
Chancellor's Office No. 106.
Secretary's Office No. 107.
Registrar's Office No. 108.
Dean's Office No. 305.

ADVISORY BOARD

HIS EXCELLENCY, JOHN K. TENER, Governor of the Commonwealth.
HON. HENRY HOUCK, Secretary of Internal Affairs of the Commonwealth.
HON. NATHAN C. SCHAEFFER, LL.D., Superintendent of Public Instruction,

FACULTY*

SAMUEL BLACK McCORMICK, D.D., LL.D., CHANCELLOR.
MARSHMAN EDWARD WADSWORTH, A.M., PH.D., Dean, Professor of Mining Geology.
ARNOLD EDWARD ORTMANN, PH.D., Professor of Physical Geography.
CHARLES ROCHESTER EASTMAN, PH.D., Professor of Paleontology.
JOSEPH ALBERT BECK, B.S., LL.B., Professor of Mining Economics and Mining Law.
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HARRY BERTINE MELLER, E.M., Assistant Professor of Mining.
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ANDREW BENNETT WALLGREN, M.D., Lecturer upon First Aid to the Injured.
HARRY NELSON EATON, A.M., Instructor in Geology and Petrography.

*The Faculty and Teaching Staff of the College, and of the Schools of Engineering, Economics, and Education, give instruction that is available for the students of the School of Mines either as required or elective work.

HORATIO CADWALLADER RAY, B.S., Instructor in Metallurgy and Ore Dressing.

HENRY LEIGHTON, A.B., Instructor in Mining Geology and Mineralogy.

OTTO EMERY JENNINGS, B.S., PH.D., Instructor in Paleobotany.

EDWARD LEWIS ESTABROOK, E.M., Assistant in Mineralogy.

JAMES ZECHARIAH ZIMMERMAN, E.M., Assistant in Mining.

MORTON LEHMEYER JANDORF, Assistant in Mineralogy.

HISTORICAL

The Legislature in the Spring of the year 1895 appropriated to the University of Pittsburgh the sum of \$50,000 for the establishment of a School of Mines in connection with the University. The Governor of the Commonwealth, the Secretary of Internal Affairs, and the Superintendent of Public Instruction are constituted an Advisory Board.

In 1895-96 the School of Mines was organized and its course outlined. Professor Daniel Carhart was made Dean, which position he retained until 1907-08. Selwyn M. Taylor, M.E., was appointed as Acting Professor of Mining Engineering, and W. G. Wilkins, C.E., was also made Acting Adjunct Professor of Mining Engineering. In 1897-98 Mr. Taylor was advanced to the position of Professor of Mining Engineering, and Mr. Wilkins to that of Adjunct Professor of Mining Engineering, which positions they held until 1900. In 1900-01 F. Z. Schellenberg, C.E., was appointed Acting Professor of Mining Engineering, which position he retained until 1903.

The first student was graduated in 1902. From 1904 to 1907, Harold Coulter George, B.S., a graduate of the School of Mines of the Pennsylvania State College, was, under Dean Carhart, in charge of the School work. His duties were effectively and well done and the School was strengthened and developed.

On Mr. George's resignation in the summer of 1907 to engage in practical work as a mine manager, the present Dean was elected, but he did not assume the full duties of his position until September 1908, owing to his remaining for the year 1907-1908 in full charge of the School of Mines at the Pennsylvania State College. Meanwhile he exercised some supervision over the School's work, reorganized the School, and assisted in planning the new School of Mines Building. The work of the School, was however, for 1907-1908 under the immediate charge of Ray Philip Farrington, B.S., a graduate of the School of Mines of the Pennsylvania State College, assisted by Louis K. Acker, Jr., E.M., a graduate of this School.

During the past three years, 1908-1911, the new School of Mines building has been erected and equipment obtained. The effect of the re-organization has been such that the attendance in that time has increased from 8 to 72 students, the Faculty from 2 to 18 and the graduating class from 1 to 18. The graduates now number 32 against 7 in the 13 preceeding years.

The most important recent change is the introduction by the

Chancellor in 1910-1911 of the practically continuous year of 45 weeks, with a summer term co-ordinate with, and giving the same subjects or their equivalents of any other term. While most mining schools give extra or summer terms for surveying, mining, and other field and laboratory work, this seems to be the first one to give during the summer the equivalent class room instruction of the other terms, thus enabling a student to substitute the summer term for any other term if he wishes. In a general way the summer term replaces the winter term for the regular student, but special courses are also given for instructors and others from different schools who desire to study certain of the subjects taught in the School of Mines.

SPECIAL ADVANTAGES

The location of Pittsburgh, in the very heart of the bituminous coal fields of the Appalachian system, and in the most richly productive oil fields of Western Pennsylvania, with the great concentration here of the mining and metallurgical interests, make this undoubtedly one of the most advantageous points in which to study Mining and Metallurgy in the United States. Some of the largest mines and smelting works in the country are accessible to the students within a few minutes' ride of the city, by rail or electric cars.

It is also conveniently located with reference to the coal fields of Ohio and West Virginia. The Pennsylvania Bituminous Coal district produced in 1907 149,559,047 tons of coal and 23,516,309 tons of coke. Within this district there are some sixteen hundred mines of which about fourteen hundred are productive and worked by seven hundred and twenty-three companies.

Amongst some of the most noted of the coal mining companies there may be mentioned: Berwind-White Coal Co., Bessemer Coke Co., Brier Hill Coke Co., Cambria Steel Co., Carnegie Coal Co., Ellsworth Coal Co., H. C. Frick Coke Co., Jamison Coal and Coke Co., Keystone Coal and Coke Co., Latrobe-Connellsville Coal and Coke Co., New York and Cleveland Gas Coal Co., Oliver and Snyder Steel Co., Penn Gas Coal Co., Pennsylvania, Beech Creek and Eastern Coal Co., Pittsburgh Coal Co., Pittsburgh and Baltimore Coal Co., Pittsburgh and Buffalo Coal Co., Pittsburgh and Eastern Coal Co., Pittsburgh Gas Coal Co., Pittsburgh and Westmoreland Coal Co., W. J. Rainey Co., Rochester and Pittsburgh Coal and Iron Co., Somerset Coal Co., United Coal Co., Vesta Coal Co., Washington Coal and Coke Co., Westmoreland Coal Co., Youghiogheny and Ohio Coal Co., Pittsburgh Plate Glass Co., etc.

The opportunities for the study of Mining in its practical sides, especially in Coal Mining, are unrivaled. Along the Metallurgical side, particularly in Iron and Steel Metallurgy, the advantages are unsurpassed.

Amongst the well known metallurgical plants there can be mentioned a few like the Carrie Furnaces, Clairton Steel Works, Clark Mills, Donora Steel Works, Duquesne Steel Works, Edgar Thomson Steel Works,

Homestead Steel Works, Isabella Furnaces, Jones & Laughlin Steel Works, Lucy Furnaces, McCutcheon Mills, Monessen Mills, Painter Mills, Pittsburg Steel Works, Union Mills, and numerous others.

Within the district tributary to Pittsburgh are over 5,000 manufacturing establishments employing 350,000 men and having an annual pay roll of \$500,000,000. The city itself has some over 800 manufacturing establishments with an aggregate annual wage per man of \$660, although the average annual wage per man engaged in industrial pursuits throughout the United States is only \$475. Pittsburgh produces 63 per cent. of all the steel made in the United States, 89 per cent. of the plate glass, and holds a leading place in numerous other manufactures.

Not only has the student the advantage of the weekly excursions made to the different mines, mills, and smelting works in the vicinity, but he is daily in contact with an atmosphere replete with mining and metallurgical enterprises. He naturally draws inspiration from the busy, bustling city with which he is surrounded and from its enthusiastic business men. The gospel of hard untiring work is preached on every side, for the School of Mines is planned for thinking, hard working, and energetic students.

During his course the student is not only in touch with vast industries but on graduation he is in a spot where his services are most naturally in demand. During his course the young man who needs to do so usually can find employment during his available time in some of the over 800 manufacturing establishments in Pittsburgh or in its numerous other industrial enterprises. Nor are the moral or intellectual opportunities to be overlooked in a city containing some 400 churches and 140 schools with over 2,200 instructors and 82,000 pupils.

In addition to the various weekly excursions to the different mines and metallurgical establishments the students have the opportunity to attend meetings and lectures of all kinds, like those of the American Institute of Mining Engineers and numerous other societies that meet regularly or occasionally in Pittsburgh. Further arrangements have been made for prominent mining and metallurgical engineers and others to give, from time to time, talks to the students of the School of Mines upon their specialties.

The School of Mines Building is near the Carnegie Institute with its geological, mineralogical, botanical, zoological, paleontological, archæological, art, and other collections and with its immense library, all of which are available for the use of students.

The building is also located in a conveniently accessible part of the city, near the Schenley Hotel, the University Club, the Soldiers' Memorial, the Carnegie Technical Schools, Eighteenth Regiment Armory, Pittsburgh Athletic Association Building, Forbes Athletic Field, Schenley Park, etc., and adjacent to some of the beautiful residence districts of the city. It can be readily reached by steam and electric cars from almost every part of the Pittsburgh district, as it is centrally located in the city. The building is not far from the United States' Experimental Testing Station, and Bureau of Mines, for the investigation of mine explosions and other factors relating to mining. Its work is readily

available for the students who are taught there: First Aid to the Injured, and Mine Rescue Work, receiving certificates therefor from the United States Government, and the United States Red Cross Association.

One of the student's greatest advantages is that he is allowed to substitute for part of his elective school work, practical co-operative work done under stated conditions, in the mines, smelting works, mills, etc. All this brings the student in direct contact with the great industrial world of which he must so soon form a constituent part. It gives him not only the chance to obtain knowledge, but it also gives him the opportunity to know how to use his knowledge on his graduation, if he has properly availed himself of his advantages.

The School also gives the student who wishes to do so the opportunity to specialize in the business or managing or operating sides of mining, metallurgical, ceramic and geological work. In this this School is apparently the pioneer in specially educating not only the engineer but also all other men who are interested in the development of the world's mineral wealth.

THE MINING INDUSTRIES

Throughout the State of Pennsylvania and the United States a deserved support has been freely given to advance Agricultural education, but no such support has been given to an education equally deserving of the fostering care of the State and Nation—that of educating men who are to care for the mineral wealth of the country—men from whom there is demanded far more knowledge, skill, and care than does Agriculture, since Nature can repair the mistakes made in the latter, while it can never restore the raw material nor the precious lives which ignorant or unskilled mining has once destroyed. The mineral wealth of the State and Nation are as much their life blood as are their agricultural products, while in this State their value is shown by the census returns to be nearly thirty millions of dollars greater. The mining industries give to the husbandman markets for his farm produce almost at his own doors; while both are the chief factors in affording the raw material for the immense sum of over eleven hundred millions of dollars derived from the manufactured products of Pennsylvania.

The Census Report on Mines and Quarries states: "Pennsylvania, which ranked second in population and manufactures and eighth in agriculture was the leading mining state in 1902, both in the number of wage-earners employed and in the value of products. Its high rank was due to the production of anthracite and bituminous coal, the wage-earners reported for the coal mines forming 84.7 per cent. of the 190,935 reported for all mines in the state, and the products of such mines forming 76.9 per cent. of the total product of \$236,871,417. The position of Pennsylvania as the leading mining state was most pronounced. Out of a total of 581,728 wage-earners engaged in mining in United States, Pennsylvania reported 190,305, or 32.8 per cent., who received as wages \$114,122,437, or 30.8 per cent. of the \$369,959,960 reported as

the total. The value of the State's production was equally high, being \$236,871,417, or 29.7 per cent. of the \$796,826,417 reported for the United States. Practically one-third of the whole mining industry of the United States, as measured by the persons employed and the value of the products, was confined to this state. While it is true that the exploitation of the enormous coal deposits has been responsible for Pennsylvania's position as the leading mining state and that this industry has assumed overshadowing proportions, it is also true that the State has produced a large variety of minerals. Of the 52 classes of minerals reported 23 were found in Pennsylvania, the State being exceeded in this respect only by California, with 26 classes, and by Virginia, with 24."

According to the United States' Geological Survey the value of the mineral products in the United States in 1907, \$2,071,607,964, or which \$1,167,705,720 were for non-metallic products, and \$903,802,244 for metallic ones.

In 1907 the value of coal produced in Pennsylvania was \$319,248,082, nearly equally divided between the bituminous and anthracite.

Pennsylvania also stood, in 1907, first of the United States in the value of its production of pig iron (\$234,952,000) or almost half of the entire output of the country, coke (\$67,638,024), Portland cement (\$19,698,006), natural gas (\$18,344,156), building stone (\$9,132,372), slate (\$3,855,640), petroleum (\$17,579,706), and lime (\$2,075,842). It also stands second only to Ohio in the value of its clay products (\$20,291,621).

SCOPE OF INSTRUCTION IN THE SCHOOL OF MINES

The School of Mines, if it properly attends to the instruction within its province, as required by the needs of the State and Nation, must cover the work of searching for the crude mineral materials of the earth, their mode of occurrence, the methods of taking them out of the ground, and their preparation for market; and it should provide instruction in every subject required for this work.

This requires that the School give instruction in Mineralogy, Petrography; Chemical, Physical, Stratigraphical, and Field Geology, particularly in their applications to Prospecting, Mining and Engineering; Paleontology and Paleobotany, with their use, in determining the age and relations of geological formations; Economic or Mining Geology including all the metalliferous and non-metalliferous deposits of use to man; Ceramics in its broadest sense or the manufacture of clays, cements, concretes, and glass; Ore Dressing and Coal Washing; Metallurgy in all its branches, comprising wet and fire assaying, hydrometallurgy and electro metallurgy; and Mining in all its numerous ramifications including First Aid to the Injured, Mine Rescue Work, Mining Law, Mining Economics, and Mining Engineering; accidents, etc., etc.

The instruction, then, either in this School or in some of the other Schools in this University, must comprise all things requisite to find and obtain the earth's mineral wealth and prepare it for market. This

work naturally arranges itself along various clearly defined lines, in each of which the training may proceed to almost any length, like Drawing and Designing; Metallurgy, including Ferrous and Non-Ferrous Metallurgy; Ceramics, including concrete, cement, and glass making; Mining, including Mining Engineering; Ore Dressing; Coal Washing, Mineralogy, Petrography, Geology, Mining Geology, Civics, and Economics. In consequence, the men educated in the School of Mines courses are engaged quite commonly as foremen, fire bosses, mine inspectors, draughtsmen, surveyors, engineers, woodsmen, prospectors, explorers, assayers, metallurgists, ceramic engineers, mill men, mining men, mineralogists, petrographers, geologists, mining geologists, quarrymen, manufacturers, superintendents, managers, agents, teachers, etc., etc.

Men trained along these lines may be employed in the humbler work about mines, mills, and smelting works, or they may have charge of the expenditure of many millions of dollars yearly and have the oversight of thousands of human beings, as well as burdened with the care of their religious, moral, social, educational, sanitary, and political welfare.

It needs but glance at the immense fields covered by the work properly belonging to this School to see that by no possibility can it all be crowded into any single four years' course that the mind of man can conceive. Either the work must all be of a very elementary and introductory character or it must be somewhat specialized; since in no way can any new thing be introduced into a curriculum without displacing some other useful subject.

The amount of work is so great that no man can do more than to obtain part of the general principles and build upon them in some one of the numerous lines of mining, metallurgical, ceramic, and geological practice.

Out of the numerous lines along which educational courses can be laid in this School of Mines, some like the following can be specified as training men:

1. To engage in prospecting and exploring work, and to possess a thorough knowledge of the useful geological deposits, the application of Mineralogy, Petrography, and Geology to Mining—prospectors, drillers, and mining or economic geologists, or mining “experts.”
2. To cope with transportation problems, mapping, surveying, laying out of towns, railroads, erecting structures, etc.—the application of the principles of Civil Engineering to Mining and Metallurgy—surveyors, superintendents, and mining engineers.
3. To design metallurgical, hoisting, and power plants, including compressors, drilling machines, etc.; to attend to ventilation and other allied problems—the application of the principles of Mechanical Engineering to Mining and Metallurgy—draughtsmen, inspectors, metallurgists, metallurgical engineers, etc.
4. To look after the electrical power, lighting, signals, haulage, electric drills, cutters, etc., in a mine—a field but slightly worked by mining men—the application of the principles of Electrical Engineering to Mining and Metallurgy—mining and metallurgical engineers.

5. To do wet and fire assaying, smelting, coke preparation, hydro-metallurgical and electro-metallurgical work, etc.—the application of the Metallurgical and Chemical principles to Mining—metallurgical engineers, metallurgists, and assayers.

6. To understand the problems involved in Stamp Mills and other concentrating plants—the Ore Dressing and Coal Washing side of Mining—mill men, superintendents, etc.

7. The management of mining or mineral properties or estates, including the mining laws, or to have a business man's training or a lawyer's education on one side and a mining or metallurgical one on the other—the application of the principles of business and law to Mining and Metallurgical properties—operators, promoters, managers, and agents.

8. To be prepared to handle the problems relating to building materials, including slates, clays, limes, mortars, cements, glass, etc.—the application of Geological and Mining principles to Ceramics, the preparation of cements, concretes, and building stones and other building materials—foremen, quarrymen, prospectors, superintendents, managers, operators, promoters, etc.

9. To become generally useful men about the smaller mines and mineral properties, who must be able to do in a limited way almost any kind of work above mentioned—mining-men, fire bosses, foremen, inspectors, superintendents, managers, etc.

10. To serve as teachers or educators for students in Mining, Metallurgy, Ceramics, Geology, Mineralogy, etc.—instructors and professors.

11. To train men for work in various lines upon the geological surveys of the country—geologists and explorers.

Men to do the above work well about mines and other mineral properties must receive a special training in and knowledge of the minerals and rocks, as well as in the geological structure of the earth, and the general methods of mining. It thus becomes necessary for the student to take the needed preparatory geological and mining studies, and to finish out his course with the special subjects he expects to use, and which are applicable to the life he intends to follow.

To repeat, it can be said that at this day it is impossible to train all men in a single course in mining, unless all are to be turned out as general utility or mediocre men, or all turned in a fixed direction, and suitable for one or two lines of mining or metallurgy only. It is not the men who know a little of everything who lead. It is rather those who realize that they know some one thing well and have the mental strength that comes from such knowledge and its attendant discipline.

The range of subjects bearing on the mineral industry is extremely wide. This, coupled with the fact that all men are endowed with a natural aptitude for some lines of work, while wholly unfitted for others, and the further fact that circumstances beyond control force some men into particular occupations, demonstrates that the student must have some liberty in selecting the studies which are to enable him to cope with his life work. This is recognized here, and met by selecting certain studies that are considered essential for any man to have

who is to devote himself to subjects germane to the purposes of this School, with additional subjects from which the student is to select enough to complete his course.

Out of the numerous schemes for courses that could be adopted to reach the end ought—to give the best, highest, and most practical education, in accordance with the demands of the times—it is thought that the plan used here is amongst the simplest that will satisfy the varied demands of the mining, metallurgical, ceramic, and geological industries, in a School of Mines that is connected with a university and which must be conducted upon a university basis. It is a combination of required or essential group, and elective or optional studies, that through the required sequences or preparatory studies conducts the student by some logical line of study; that could otherwise be provided for with greater difficulty as most schools try to do by laying down more or less numerous courses of the common required pattern similar to the Advisory Courses given in the later pages of this bulletin.

The student is referred to the complete title and requirements for each subject given beyond for the subjects that are taught in the School of Mines. For a description of the subjects taught in the other schools and colleges of the University the student is referred to the University catalog which will be sent upon application to the Secretary of the University. In selecting his subjects he must be governed by the requirements in each case and by the general rules.

Students in the School of Mines have required studies in, or they are allowed to elect studies in the College and Schools of Engineering, Education, Economics, and Astronomy; if they are properly prepared, by arranging with the Dean of that school, the instructor in the subject selected, and the Dean of the School of Mines.

Languages, Literature, History of Religion, Philosophy, Psychology, History, Mathematics, Physics, Chemistry, Zoology, Botany, Bacteriology, and Music are taught in the College.

Drawing or Graphics, Mechanics, Practical Mechanics or Shop Work, and Civil, Chemical, Sanitary, Mechanical, Mechanical Railway, and Electrical Engineering subjects belong to the province of the School of Engineering.

Instruction in Methods of Teaching generally appertain to the School of Education, but the method of teaching a special subject may be given in the school giving instruction in that special subject.

The School of Economics has charge of the instruction in Political Economy, Money, Banking, Transportation, Labor Problems, Finance, Insurance, Accounting, Political Science, Sociology, etc.; but the applications of these subjects to special lines, may be given in the school that has charge of such special work.

The School of Astronomy gives the courses in Astronomy and its applications.

The Department of Industrial Research under the direction of Professor Robert K. Duncan has connected with it Fellows engaged in research along special lines. These Fellows are available to give instruction in their specialities each week.

The Fellows in the Department of Industrial Chemical Research are chosen from the leading Universities and come with the highest recommendations as to scholarship and ability and are specialists in their departments. Bringing such men to the University of Pittsburgh means a school of Chemical Engineering of the highest type.

REQUIREMENTS FOR ADMISSION

All candidates for admission to the School of Mines must be at least seventeen years of age and furnish testimonials of good moral character. Those coming from other colleges must present certificates of an honorable dismission. Special opportunities are given to students of mature age, and, under certain conditions credit is allowed for practical (co-operative) work.

METHODS OF ADMISSION

Admission is by one of the following methods:

I. **EXAMINATION.** Examinations are held at the University, beginning at 9 o'clock in the morning, on the three days following the Commencement in June, and on the three days preceding the opening of the College year in September. For 1911 these dates fall on June 15, 16, and 17, and September 21, 22, and 23; in 1912 on June 13, 14, and 15, and September 19, 20, and 21.

Certificates of the College Entrance Examination Board and of the New York Regents are accepted in lieu of the entrance examination at the University.

II. **CERTIFICATE FROM ACCREDITED SCHOOLS.** Instead of examination, certificates from high schools and academies whose work has been approved by the University, and whose courses prepare for the Freshman class will be accepted. The official blank or certificate provided by the University must be used. It may be obtained, by application, from the Registrar or Dean.

III. By dismission from other colleges. Students from colleges offering equivalent courses will be given provisional credit for the work done and admitted to advanced standing without examination. If their work proves satisfactory, the provisional credits are made permanent.

IV. Students showing satisfactory evidence of ability, but who are not candidates for a degree, may be admitted without examination to take such work as they are prepared for. This provision is especially intended for persons of mature age and who have had practical experience. This opportunity has been taken by many who are from 25 to nearly 60 years of age.

SUBJECTS OF EXAMINATION

For admission to the School of Mines the student who is a candidate for a degree must offer sixteen units. The unit is the equivalent of five recitations of 40 or 50 minutes every week for the school year. It is intended to raise these requirements as rapidly as practicable, by requiring, for all regular students entering the School of Mines, one unit

in Trigonometry, in 1911; one unit in Zoology for those entering in 1912; and one-half unit each in Astronomy and Botany for those entering in 1913; and one-half unit each in Bookkeeping and Freehand Drawing for those entering in 1914, as the student needs all these subjects in his subsequent work.

The units are as follows for 1911:

English, 3 units.

Plane and Solid Geometry, $1\frac{1}{2}$ units.

Algebra (to Theory of Equations), $1\frac{1}{2}$ units.

Plane Trigonometry, 1 unit.*

History and Civil Government, 1 unit.

French or German or Spanish or Italian or Latin or Greek, 2 units.

Physics, 1 unit.

Chemistry, 1 unit.

Four units to be selected from the following:

English 1 or 2 units.

History, $\frac{1}{2}$, 1 or 2 units.

French or German or Spanish or Italian or Latin or Greek, 1 or 2 units.

Bookkeeping, $\frac{1}{2}$ or 1 unit.

Astronomy, $\frac{1}{2}$ or 1 unit.

Botany, $\frac{1}{2}$ or 1 unit.

Zoology, $\frac{1}{2}$ or 1 unit.

Drawing, $\frac{1}{2}$ or 1 unit.

Shop Work, $\frac{1}{2}$ or 1 unit.

Physiography, $\frac{1}{2}$ or 1 unit.

Physiology, $\frac{1}{2}$ or 1 unit.

The following subjects are accepted for admission:

ENGLISH COMPOSITION AND LITERATURE

a. Three units. The preparation should include the following subjects:

(1) GRAMMAR. It is expected that the applicant will be familiar with the essentials of English grammar, and will be able to explain the construction of sentences that occur in the literature he has read.

(2) COMPOSITION AND RHETORIC. The student should know the elementary principles of Rhetoric, and should be able to apply them in the construction of sentences and paragraphs, and in the planning of essays. The examination is chiefly practical, and involves the ability to write good English.

No student will be accepted whose paper is notably deficient in logical development of the subject, or in such details of form as spelling, punctuation, grammar, and division into paragraphs.

*Those students who are not prepared in Plane Trigonometry have the opportunity to take this subject in the regular undergraduate classes.

(3) LITERATURE. The books recommended are the Uniform College Entrance requirements in English. Other similar works will be accepted as equivalents.

The candidate is required to write one or more paragraphs on each of several subjects chosen from a considerably larger number given in the examination paper. The questions on all the books assume a knowledge of subject-matter and structure, but those on the books prescribed for study and practice call for more detailed treatment than those on books prescribed for reading.

A—The books prescribed for reading and practice are:

For students entering in 1911, 1912, and 1913:

Ten units, two from each of the following groups. Each unit is set off by semicolons.

Group 1. The Old Testament, including the most important narrative parts of Genesis, Exodus, Joshua, Judges, Samuel, Kings, and Daniel, together with the books of Ruth and Esther; the Odyssey, with the omission of Books I-V, XV-XVII; the Iliad, with the omission of Books XI, XIII-XV, XXI; Virgil's *Æneid*. English translation of the Odyssey, the Iliad, and the *Æneid*, of acknowledged literary merit, must be used.

Additional units from Groups 2-5 may be substituted for the two units of this group.

Group 2. Shakespeare's *Julius Caesar*; *The Merchant of Venice*; *As You Like It*; *A Midsummer-Night's Dream*; *Twelfth Night*; *Henry V*.

Group 3. Goldsmith's *The Vicar of Wakefield*; either Scott's *Ivanhoe* or Scott's *Quentin Durward*; Hawthorne's *The House of the Seven Gables*; Thackeray's *Henry Esmond*; either Dickens' *A Tale of Two Cities* or Dickens' *David Copperfield*; Mrs. Gaskell's *Cranford*; George Eliot's *Silas Marner*; Stevenson's *Treasure Island*; Defoe's *Robinson Crusoe*, Part I.

Group 4. The de Coverley Papers in *The Spectator*; Franklin's *Autobiography*; Bunyan's *Pilgrim's Progress*, Part I; Irving's *Sketch-Book*; Macaulay's *Essays on Clive and Hastings*; Thackeray's *English Humorists*; selections from Lincoln, including at least the two Inaugurals, the speeches in Independence Hall and at Gettysburg, the *Last Public Address*, and the *Letter to Horace Greely*, together with a short memoir or estimate; Parkman's *Oregon Trail*; Thoreau's *Walden*; Huxley's *Autobiography* and selections from *Lay Sermons*, including addresses on *Improving Natural Knowledge*, *A Liberal Education*, and *A Piece of Chalk*; Stevenson's *Inland Voyage* and *Travels with a Donkey*.

Group 5. Palgrave's *Golden Treasury* (First Series), Books II and III, with special attention to Dryden, Collins, Gray, Cowper, and Burns; Gray's *Elegy in a Country Churchyard* and Goldsmith's *The Deserted Village*; Coleridge's *The Ancient Mariner* and Lowell's *The Vision of Sir Launfal*; Scott's *The Lady of the Lake*; Byron's *Childe Harold*, Canto IV, and *The Prisoner of Chillon*; Palgrave's *Golden Treasury* (First

Series), Book IV, with special reference to Wordsworth, Keats, and Shelley; Poe's *The Raven*; Longfellow's *The Courtship of Miles Standish*, and Whittier's *Snow-Bound*; Macaulay's *Lays of Ancient Rome*, and Arnold's *Sohrab and Rustum*; Tennyson's *Gareth and Lynette*, *Lancelot and Elaine*, and *The Passing of Arthur*; Browning's *Cavalier Tunes*, *The Lost Leader*, *How They Brought the Good News from Ghent to Aix*, *Home Thoughts from Abroad*, *Home Thoughts from the Sea*, *Incident of the French Camp*, *Hervé Riel*, *Pheidippides*, *My Last Duchess*, *Up at a Villa—Down in the City*.

B. The books prescribed for study and practice are:

For students entering in 1911, 1912, and 1913:

Shakespeare's *Macbeth*; Milton's *Lycidas*, *Comus*, *L'Allegro*, and *Il Penseroso*; Burke's *Speech on Conciliation with America*, or Washington's *Farewell Address* and Webster's *First Bunker-Hill Oration*; Macaulay's *Life of Johnson* or Carlyle's *Essay on Burns*.

Applicants who are not graduates of accredited high-schools, or who have not passed the uniform entrance-examinations, will be required to present themselves at the University of Pittsburgh entrance-examinations, held the three days preceding the opening of the Fall Term.

b. One unit.

Advanced standing in English may be given to the graduates of high-schools that have exceptionally strong and thorough courses in English throughout the entire four years. This requires additional work in literature and, especially, a thorough knowledge of the elementary principles of Rhetoric, and the ability to write good English.

MATHEMATICS

a. ALGEBRA THROUGH QUADRATICS.

One unit.

The four fundamental operations for rational algebraic expressions. Factoring, determination of highest common factor and lowest common multiple by factoring. Fractions, including complex fractions, ratio, and proportion. Linear equations, both numerical and literal, containing one or more unknown quantities. Problems depending on linear equations. Radicals, including the extraction of the square root of polynomials and of numbers. Exponents, including the fractional negative.

Quadratic equations, both numerical and literal. Simple cases of equations with one or more unknown quantities, that can be solved by the methods of linear or quadratic equations. Problems depending on quadratic equations. The binomial theorem for positive integral exponents.

b. PLANE GEOMETRY.

One unit. The usual theorems and constructions of the text-books, including the general properties of plane rectilinear figures; the circle and the measurements of angles; similar polygons; areas; regular

polygons and the measurement of the circle. The solution of numerous original exercises. Applications to mensuration.

c. ADVANCED ALGEBRA.

One-half unit.

Ratio, proportion and variation; variables and limits; properties of series, including the binominal theorem for exponents of all kinds; the progressions; use of undetermined coefficients; permutations and combinations; logarithms, computation and use; summation of recurring series; method of differences; interpolation.

d. SOLID GEOMETRY.

One-half unit.

Solid Geometry. The usual theorems and constructions of good text-books, including the relations of planes and lines in space; the properties and measurement of prisms, pyramids, cylinders, and cones; the sphere, and the spherical triangle. The solution of numerous original exercises, including loci problems. Applications to the mensuration of surfaces and solids.

e. PLANE TRIGONOMETRY.

One unit.

The subjects treated are the functions of angles, goniometry, trigonometric equations, solution of right and oblique triangles and applications. Text-book, Wentworth's *Plane Trigonometry*, with tables or any other equivalent text.

HISTORY

One unit.

a. ANCIENT HISTORY. With special reference to Greek and Roman history, and including also a short introductory study of the more ancient nations and the chief events of the early Middle Ages, down to the death of Charlemagne (814).

b. MEDIAEVAL AND MODERN HISTORY. European history, from the death of Charlemagne to the present time.

c. ENGLISH HISTORY.

d. AMERICAN HISTORY AND CIVIL GOVERNMENT.

Each of the above topics is intended to represent one year of historical work, wherein the study is given five times per week, or two years of historical work, wherein the study is given three times per week.

LATIN

One unit each.

a. GRAMMAR and elementary prose composition; a thorough knowledge of all regular inflections, all common irregular forms, the fundamentals of syntax, and a select vocabulary.

b. CAESAR, *Galic War*, Books I-IV, or the equivalent from other books of the *Galic War* or the *Civil War*, or Nepos, *Lives*. The examination consists of translation at sight of narrative prose similar to the above.

c. CICERO, the four orations against Catiline and the orations for Archias and for the Manilian Law, or the equivalent from other orations of Cicero or from his letters, or from Sallust, Catiline and Jugurtha, except that the orations for the Manilian Law and for Archias are required. Advanced prose composition. The examination consists of translation (together with historical, literary, and grammatical questions) partly of passages taken from the two required orations, and partly at sight of passages similar to the above in vocabulary, syntax, and range of ideas. In addition, there is an examination in prose composition.

d. VIRGIL, *Æneid*, Books I-VI, or the equivalent from other books of the *Æneid*, or from the *Bucolics* or *Georgics*, or from Ovid, *Metamorphoses*, *Fasti*, or *Tristia*, except that *Æneid* I, II and either IV or VI are required. The examination consists of translation (together with questions on grammar, prosody, literary and historical allusions, and subject-matter) partly of passages taken from the required books, and partly, at sight, of passages similar to the above in vocabulary, syntax, and range of ideas.

GREEK

One or two units.

a. GREEK GRAMMAR and the elements, forms, constructions, conditional sentences, indirect discourse, etc. Composition. Translation into Greek of easy Attic prose based on the *Anabasis*.

b. XENOPHON'S *Anabasis*. Four books. HOMER, Books I and II of the *Iliad*.

GERMAN

One unit each.

a. ELEMENTARY GERMAN. During the first year the work should comprise (1) careful drill upon pronunciation; (2) the memorizing and frequent repetition of easy colloquial sentences; (3) drill upon the rudiments of grammar; (4) abundant easy exercises designed, not only to fix in mind the forms and principles of grammar, but also to cultivate readiness in the reproduction of natural forms of expression; (5) the reading of from 75 to 100 pages of graduated texts from a reader, with constant practice in translating into German easy variations upon sentences selected from the reading lessons.

b. SECOND YEAR GERMAN. During the second year the work should comprise (1) the reading of from 150 to 200 pages of literature in the form of easy stories and plays; (2) practice as before, in the translation into German of easy variations upon the matter read, and also in the reproduction, orally and in writing, of the substance of short and easy selected passages; (3) continued drill upon the rudiments of grammar.

Stories suitable for the elementary course can be selected from the following list: Grimms' *Märchen*, Gerstäcker's *Germelshausen*, Heyse's *L'Arrabbiata*, Storm's *Immensee*, Baumbach's *Der Schwiegersohn*, Schokke's *Der Zerbrochene Krug*, Hillern's *Höher als Die Kirche*.

Among shorter plays the best available are, perhaps: Benedix's *Der Prozess*, *Der Weiberfreund*; Elz's *Er ist nicht eifersüchtig*; Wichert's *An der Majorsecke*; Wilhelm's *Einer muss heiraten*.

c. THIRD YEAR GERMAN. The work should comprise the reading of about 400 pages of moderately difficult prose and poetry, with constant practice in giving, sometimes orally and sometimes in writing, paraphrases, abstracts, or reproductions from memory of selected portions of the matter read; also grammatical drill upon the less usual strong verbs, the use of articles, cases, auxiliaries of all kinds, tenses and modes, and likewise upon word-order and word-formation.

Suitable reading matter for the third year can be selected from such works as the following: Freytag's *Die Journalisten* and *Bilder aus der deutschen Vergangenheit*, for example, *Karl der Grosse*, *Aus den Kreuzzügen*, *Doktor Luther Aus dem Staat Frederichs des Grossen*, Gerstäcker's *Irrfahrten*, Hoffman's *Historische Erzählungen*, Riehl's *Der Fluch der Schönheit*, Schiller's *Wilhelm Tell*, *Der Neffe als Onkel*, *Das Lied von der Glocke*, Wildenbruch's *Das edle Blut*.

FRENCH

One unit each.

a. ELEMENTARY FRENCH. In the first year the work should comprise (1) careful drill in pronunciation; (2) the rudiments of grammar; (3) easy composition; (4) the reading of from 150 to 200 duo-decimo pages of easy French prose; (5) writing French from dictation.

b. SECOND YEAR FRENCH. During the second year the student should read from 300 to 400 pages of easy modern prose. Suitable texts are: Halévy's *L'Abbé Constantin*; Bruno's *Le tour de la France*; Malot's *Sans famille*; Labiche and Martin's *La poudre aux yeux* and *Le voyage de M. Perrichon*; Dumas' *L'Évasion du Duc de Beaufort*. Continued drill upon the rudiments of grammar, the mastery of the chief irregular verbs, dictation, practice in French conversation.

c. THIRD YEAR FRENCH. In the third year from 500 to 600 pages of French of ordinary difficulty should be read. The essentials of French syntax are required, with constant practice in the use of spoken French. Suitable texts are: Daudet's *Contes*; About's *Le Roi des Montagnes*; Mérimée's *Colombo*; Augier's *Le Gendre de M. Poirer*; Molière's *Le Bourgeois Gentilhomme*; Maupassant's *Contes*; George Sand's *Le Mare au Diable*; Scribe's plays.

SPANISH

One unit each.

a. ELEMENTARY SPANISH. Hill's and Ford's *Spanish Grammar*, reading, composition, conversation. Bransby's *Spanish Reader*, Selgas, *La*

Mariposa Blanca; Galdos, *Dona Perfecta*; Tamayo, *Lo Positivo*; Giese's *Spanish Anecdotes*.

b. SPANISH CLASSICS. Cervantes, *Don Quixote*; Lope de Vega, Calderon. Fitz-Maurice-Kelly, *History of Spanish Literature*.

c. COMMERCIAL SPANISH. Reading of commercial Spanish. Commercial correspondence. Conversation. The vocabulary of every day life is emphasized.

ITALIAN

One unit each.

a. ELEMENTARY ITALIAN. Elementary grammar, dictation, reading, memorizing, conversation, and easy composition. Motto's *Elementary Italian Grammar*. Cattaneo, *Italian Reader*. DeAmicis, *Cuore*. Other selections from modern authors will be assigned by the instructor.

b. ITALIAN, INTERMEDIATE COURSE. Study of Italian Grammar in Italian. Conversation and advanced prose composition. Italian literature of the XVIII and XIX centuries. Selected readings and brief lectures in Italian. Manzoni, *I Promessi Sposi*, will be read in full.

PHYSICS

One unit.

The candidate will be expected to be familiar with the fundamental principles of physics. A sufficiently extended treatment of the subject will be found in any of the principal text-books now in use in secondary schools, such, for instance, as Milliken and Gale, Carhart and Chute, Hadley, Mann and Twiss.

It is furthermore very desirable for the student to have received training in laboratory work, but for the present no laboratory work will be required.

CHEMISTRY

One unit.

The knowledge gained, should be sufficiently comprehensive to include all broadly fundamental facts, and exact. Laboratory work, emphasizing descriptive chemistry, is necessary, and notes of this work must be presented. Much attention should be given to solutions of problems.

ZOOLOGY

One-half or one unit.

In Zoology the classification and order of development of animal life are most desired owing to their value in the subsequent required geological studies.

BOTANY

One-half or one unit.

The same things relating to vegetable life are asked as in Zoology
i. e. classification and order of development.

BOOKKEEPING

One-half or one unit.

The general principles of bookkeeping: Thorough drill in the theory of accounts, debit and credit, cash book, journal, posting, taking trial balances, inventories, balance sheets, loss and gain accounts, changing from single entry to double entry, from proprietorship to partnership, from partnership to corporation.

PHYSIOGRAPHY

One-half or one unit.

This subject, otherwise known as Physical Geography, must have been pursued as a special subject and not as a part of the earlier study of general geography, and a standard text-book, dealing with the subject solely, must have been used.

DRAWING

One-half or one unit.

Either free-hand or mechanical drawing, or both, may be offered. Specimens of the work done must be presented, properly certified by the instructor, with a statement of the length of time taken in the course which they represent.

SHOP-WORK

One-half or one unit.

The work done must usually have been of the systematic kind prescribed in courses of manual training.

PHYSIOLOGY

One-half or one unit.

The usual high school course using any standard text.

CONDITIONS

No applicant with more than three entrance conditions will be admitted as a regular student. It is highly desirable that students should enter without conditions.

Preparation for the School of Mines work is not provided for by the University, except partially during the Summer Term and in Plane Trigonometry.

SCHOLARSHIPS

Through the liberality of friends of the University five scholarships are offered in the School of Mines. These scholarships entitle the holder to free tuition, and are to be awarded to the sons of men engaged in mining. One of these scholarships is limited to residents of Allegheny

County; the others are available to those residing in Western Pennsylvania.

As many *Senatorial Scholarships* as there are state senators in Pennsylvania are also available for students of the School of Mines. The State Senator from each senatorial district selects the student who is to be his representative, and the prospective student should make application to him.

SEMESTERS, TERMS, AND CREDITS

For a number of years the school year was divided into two semesters of approximately seventeen weeks each. Commencing with September, 1910, the school year was divided into four terms of respectively about 12 weeks each as follows: Fall Term, 12 weeks; Winter Term, 12 weeks; Spring Term, 11 weeks; and Summer Term, 10 weeks. These terms, for educational purposes, are considered co-ordinate and equal, and the scholastic year for any student is any three of these terms that he may select to attend.

The basis for graduation is the accomplishing of sufficient work to obtain a certain number of *units* which are variously denominated *credits* or *hours*, (credit hours) or *units*. The former unit of credit in the School of Mines was based upon one hour of quiz or recitation or lecture or three hours of laboratory or shop or field work each week for one semester. Under the school requirements prior to 1908, students who graduated in the class of 1911 obtained 18 credits a semester or a total of 144 credits for the four years as a minimum.

Students of 1912 and subsequent classes under the regulations that went into effect in 1908, have to obtain 23 of the same credits each semester, or 184 credits to graduate in 8 semesters. Under the present *term system* the credits are based upon the terms and not upon semesters. In this case the unit or credit is one hour of quiz or recitation or lecture* or three hours of laboratory or shop or field work a week for one term, *i. e.*, 3 credits will require of the student 3 hours in the class room or 9 hours in the laboratory for each week of any term, or it may be 1 hour recitation and 6 hours laboratory work, or 2 hours recitation and 3 hours laboratory work, or any other arrangement that will give the proportionate time; or 276 term credits to graduate in 12 terms. Each *term credit* is thus seen to be 2-3 of a *semester credit*. The relations of different credits are shown here:

144 Semester Credits = 216 Term Credits for Graduation.

184 Semester Credits = 276 Term Credits for Graduation.

The opportunity is given by the above arrangement of terms for a student who is mature or exceptionally strong mentally and physically to

*In lectures the credits vary according to the purpose of the lecture. A lecture given for explanatory or illustrative purposes is classed as a laboratory hour; but one upon which a recitation or quiz is based is considered as a recitation hour.

graduate in three years by taking four terms each year. The same opportunity is offered to any one taking advantage of the *Practical Work* (or as it has been more recently called "Co-operative Work") as given below. The *Elective System* of this School also assists the able and hardworking students to shorten their time.

PRACTICAL (CO-OPERATIVE) WORK

In accordance with the custom introduced into this School in 1908 the student is allowed to substitute for his other elective work one year of *Practical* or *Co-operative Work*. Under the new distribution of terms, instead of taking his *Practical Work* during vacation time as heretofore, the student may engage upon this work for one entire year or for one or more terms a year as is best for him. Naturally students who have already considerable practical experience should devote their time chiefly or entirely to their theoretical studies, while those whose work has been theoretical should engage in Practical Work during most if not all of their allowed time, in order to better prepare them for their future life's work.

Credits are allowed as follows: One term of thirteen weeks of Practical Work is considered a regular term and the student will receive 18 credits for each completed 13 weeks of practical work, or 72 credits for one year of 52 weeks given to such work either consecutively or in detached parts. Proportionate credit will be given for a shorter time than 13 weeks, but it must not be less than 4 weeks.

In order to obtain credits for Practical or Co-operative Work the student must first arrange with the Dean of the School and the instructor who has charge of the subject, the details of the work, and give the name of the company and the location. In order to avoid mistakes this must be done in writing and the records kept on file. When the work has been completed, the student is further to present from the company for which he has worked a certificate stating the kind, character, and grade, of work done and time spent. The student must also present a written thesis giving in detail an account of the work he has done and its principles, and then pass a written or oral examination upon the work and the principles involved.

Only in exceptional cases will credit be given for any Practical or Co-operative Work done before enrollment in this School of Mines. The cases in which such credit for Practical or Co-operative Work will be given are those in which the student is a man of age and experience, and has had extended practice in the work in question or has obtained a prominent place in such work. In all these cases thesis and examination are required as stated above.

FIXED AND ELECTIVE WORK

In order to meet the needs of the School of Mines, the wants of the various students, and to save the usual multiplicity of required courses, the studies are divided into two classes: *Fixed* and *Elective*. The *Fixed Studies* are separated into two divisions, those that must

be taken by every candidate for a *Bachelor of Science* degree and those that are essential for an *Engineering* degree.

The degrees available in the School of Mines are the *Bachelor of Science Degrees* and the *Engineering Degrees*. These degrees do not differ in the length of time or in the number of credits required, or in the difficulty of the studies, but solely in the direction of these studies. For the Bachelor of Science Degrees the higher mathematics and mechanics are not required, however much they may be desired, but instead equally useful branches; while the higher mathematics and other engineering branches are demanded for any Engineering Degree.

It is not considered that there is any essential difference in the case or difficulty of obtaining any of these degrees beyond that introduced by the mental constitution of the student himself. It is well known that the requirements given below for the Bachelor Degrees contain all the mathematics the average mining engineer has occasion to use in his actual practice, and it is therefore thought best to allow the student more time for the acquirement of business principles, organization, management, law, accounting, facility in the use of English, and the numerous other subjects so essential to successful management in the various geological, mining, and metallurgical industries; for in any full curriculum nothing new can be put in without taking out some other valuable and useful subject.

The Engineering Degrees are given to those persons who specially desire to prepare themselves for the highest engineering work and are fully equal to those given in other engineering schools.

A large proportion of the studies required for the Engineering degrees are also essential to obtain the Bachelor of Science degrees, and the requirements for both will be given a little later.

Besides the elective subjects given in the School of Mines the student can elect any subject given in the College and the Schools of Engineering, Economics, Education, and Astronomy if he has had the previously required studies. In every case consultations should be held with each instructor whose work is selected in order to avoid mistakes. A student must elect his studies in sequence.

In special cases, particularly in the advanced subjects, and in the laboratory work, more hours can be taken than those specified in the catalog, by means of a petition and the consent of the instructor and the Dean.

Changes in hours or subjects or terms will be made from time to time to meet the changes in the courses in the other Schools of the University or the needs of this School.

Certain of the electives or options announced are naturally to be given every year, others are given only every other year or every third or fourth year as needed; still others are only given when asked for by a sufficient number of students, which in general may be stated for every elective to be at least five. All prospective students desiring to take up the higher elective work should write to the Dean concerning it, so they can be informed whether the work in question will be given or not during any special year or term. So far every subject asked for by

even one properly qualified student has been given. Long experience had shown that every subject announced in the School of Mines could be given as soon as asked for by a sufficient number of properly qualified students. This has been done and will continue to be accomplished if this School of Mines is properly sustained. There is no question but that an elective system like this requires harder and more self denying work on the part of the instructor and greater executive care on the part of the Dean than does the usual system.

Since the numbers and varieties of the subjects offered are very large it may be stated in explanation that these are mainly given as matters of convenience for administrative and record purposes, and are the results of an extended and varied educational experience. The arrangements, rules, methods, and subjects are in every case the result of experience and study, and no part is inserted for any reason except to aid in the development of the School within its legitimate fields, and to avoid the usual troubles and difficulties that beset a rapidly growing school. Although most of the subjects are outlined for three or more terms yet in practice they will be arranged to suit the needs of the students taking them, that is the instruction may cover three or more terms for the specialists, or it may be given in one term or even several subjects may be united in one term for those students who only wish a general knowledge of those subjects.

While it had never been done, so far as known, previously to 1906 the simple expedient of laying out the entire school frame work, on as large a scale as it then can be seen will ever be needed, saves all difficulties, for a time at least. Such a system provides not only for the regular student, but it also arranges for the special men who desire to devote their entire time to one or two subjects either for a few weeks, months, or years.

The purpose is not only to provide work so that the student desiring to do so can obtain a thorough general training as an engineer along the usual lines; but also to take care of those men who wish and are qualified to specialize along certain mining, metallurgical, ceramic or geological lines. In this way the general and the special student are cared for, along the lines of their natural aptitude.

The elective system used here lends itself more readily than does the usual system in caring for the graduate or undergraduate of the usual college course, and enables him to obtain suitable credit for his preceeding work. In this way such students can ordinarily save from one-half a year or a year or more than they usually can in fitting their preceeding course into that of the technical school they wish to join.

This School has been laid out expressly to provide amply for the graduate, the advanced undergraduate, and to the special men of age and experience. From this it has followed that the great majority of the students enter from other schools with advanced standing receiving full credit for all work they have satisfactorily done previously to entrance. The practical or co-operative elective work also greatly assists the men of age and experience.

The adoption of a suitably arranged *elective system* enables men to be graduated along the lines of their highest adaptability and efficiency and thus prepares them for greater future usefulness. This also enables the School to graduate a larger proportion of its entering students than most schools do, without in any way lowering its standard, for an equal amount of work is demanded from all—as it is the subject studied and not the amount of work that is varied. The work is fitted to the man and not the man to the work—or the School is for the student but only for the student who is willing to work. In this day of *conservation of our resources* it would certainly seem that the retention and graduating of a larger proportion of young men entering technical schools than the customary 25, 50, or 75 %, are most praiseworthy objects.

The elective studies are arranged in sequence and to take any one it is necessary for the regular student to have passed in the preceding preparatory work. All electives are selected under the advice and supervision of the Dean and the other instructors in the School. It is the duty of all instructors to aid and to guide the student in his choice, and he has the right to ask for suitable information. At the outset the student is trained to understand the sequence, value, and the use of the studies he takes. Further, he starts upon the special work of his course during his first year, and thus as he proceeds he readily sees the correlation of his studies and begins to realize his educational needs. In the latter portion of his course this enables him to select wisely and to study with interest such subjects as: Economics, Accounts, Business Principles, Political Science, Ethics, Philosophy, Psychology, Literature, Sociology, and others, which are extremely important and valuable to any mining man, and which the *elective system* here enables a student to take, if he desires. It is all important that the student should master the English Language and be able to speak and write it clearly, fluently, and accurately. It is also essential that he should have a good business training.

Teachers and others of age and experience whose time is limited are allowed to take subjects out of the regular order instead of in sequence as is required of the regular students. This is done so as to save the time of the mature men, with the understanding that they will do the necessary extra study to keep up in the more advanced subjects. This arrangement is especially made in the case of those persons who can attend during the Summer Term only, so that they can cover their special work in that term so far as it is possible.

GRADUATE INSTRUCTION AND DEGREES

The *Graduate Instruction* in the School of Mines is under the general supervision of the Graduate School when the student is a candidate for one of the *Graduate Degrees*, i. e., M. A., M. S., or Ph. D. The specific direction of this work belongs to the Dean and Faculty of the School of Mines, so far as the work done by the student is in this School. So also the work of Graduate Students who are not intending to be candidates for the higher degrees comes under this School's direction.

Intending students are referred to the part of the catalog relating to the Graduate School.

The instruction in the School of Mines is arranged in two divisions: One division consists of the more elementary and the advanced instruction in the class rooms and laboratories. Much of this work is the same as that given in most institutions under the head of GRADUATE COURSES, but here it is all classed as UNDERGRADUATE COURSES. Owing to the *plan of sequence of studies* the advanced subjects are only open to those undergraduates who have shown special aptitude for the work in question and are able to compare well with the average graduate student. All this work is open to the graduate students and is primarily intended for them.

The second division is devoted to research work in any of the subjects coming within the proper scope of the School of Mines and is intended for the use of properly prepared graduates. All these subjects require original research work which will be done under the guidance of the instructors in the School of Mines. The subjects have been laid out to show in general to the prospective graduate student some of the suggested lines of research, but the subjects and work will be arranged to suit the various demands. The credits and hours are given simply to assist in keeping an approximate record of the graduate student's work, but his standing and degrees will depend upon the work done and the ability for research shown and not upon the number of hours.

Graduate students who have not been able in their undergraduate days to obtain the requisite elementary instruction in the subjects they wish to study can readily receive that instruction in the courses given in the first division.

SHORT COURSES IN MINING

To meet the needs of students of age and experience who desire a mining or metallurgical education, but who are unable to take a complete four years' course, and such others as wish to prepare for the examinations of mine inspectors, foremen, and fire bosses, courses of instruction have been provided covering two years. Those preparing solely for the examinations for certificates of Fire Boss or Foremen, may omit certain of the subjects regularly scheduled in the two year courses and can therefore shorten their period of study. These courses enable the student to obtain instruction in Crystallography, Minerology, Petrography, Paleontology, General and Field Geology, Mining Geology, Mining, Ore Dressing and Coal Washing, Mathematics, Plane and Mine Surveying, Mine Gases, First Aid, Mine Rescue Work, General Chemistry, Qualitative and Quantitative Chemical Analysis, Ceramics, Drawing, Designing, Assaying, Metallurgy, Carpentry, Wood Turning, Forging, Pattern Making, Foundry, Machine Tool Work, etc., etc. The requirements for admission to these courses are the same as those for the regular four years' course, except for the Special Student. It is intended to prepare the student for general mining, mining law, metal-

lurgical, assaying, ceramic, paleontological, petrographical, and geological work.

In order to meet the needs of different students and to give some general training, elective work is offered, and a student is allowed to elect any work that he is properly prepared to take. Every student needs to take each term at least twenty-three credit hours, including the required work, if he is to finish his course in two years.

The electives need to be selected with care and with reference to the results desired. The Dean and the other instructors are always willing to assist the students in their selections, and every schedule has to be approved by the Dean before it can stand.

A student completing a course will receive a certificate to that effect on his making application to the Registrar of the University.

To complete a two years' Short Course the student must obtain 138 term credits; or a total of 53 credits in required work and 85 credits in elective work, of which at least 25 must be in the group in which the student desires to obtain his certificate. The required work is the same as that asked for in the Bachelor of Science degrees, but no credit is allowed for *Practical (Co-operative) Work*, owing to the brevity of the courses.

Short Courses can be taken in Ceramics, Geography, Geology, Inorganic Geology, Organic Geology, Metallurgy, Ferrous Metallurgy, Non-ferrous Metallurgy, Electro-Metallurgy, Hydro-Metallurgy, Assaying, Crystallography, Mineralogy, Mining, Mining Economics, Coal Mining, Metal Mining, Mining Geology, Metallites, Memetallites, Mining Law, Ore Dressing, Coal Washing, Paleontology, Paleozoölogy, Paleobotany, and Petrography; or in the same subjects as those available for the Bachelor of Science degrees.

For Advisory Short Courses see the later part of the Bulletin.

SPECIAL STUDENTS AND MEN OF AGE AND EXPERIENCE

The Special Students in the School of Mines are divided into two classes:

1. *Students taking irregular or special courses* owing to lack of time to take an entire course. They are under the general rules of the School and they are expected to carry a full schedule of work unless exempted for special reasons.

2. *Persons of suitable age and experience in practical work* will be admitted without examination to take such studies as the different instructors shall be satisfied they are qualified to pursue.

Long experience with the latter class of students has shown that they make most valuable and energetic workers, and have a very beneficial influence upon the undergraduate students. This division of Special Students is designed for men of an active and practical business life, usually in some department of Mining, Ceramics, Geology, or Metallurgy, who feel the need of further education that will assist them in their

future work. Results have demonstrated that such an opportunity as is here afforded has been of distinct and lasting benefit to such students, oftentimes placing them upon a much higher plane in life than otherwise they could have reached.

This work is designed also to assist persons into whose hands has come the management of estates connected with mining industries, to whom a certain amount of knowledge of Mining Law, Mining, Economics, Business Law, Accounting, and allied subjects is not only useful but essential.

In the same way, men engaged in prospecting have found the special study of Mineralogy, Geology, and Mining Geology invaluable to them.

The School of Mines especially desires to aid all who wish to increase their stock of knowledge in the subjects taught in it, and it will cordially welcome all such special students and give them every opportunity it can.

It is intended in this way to assist those who are preparing to pass examinations for the various positions of mine inspector, mine foreman, fire boss, etc. All persons of suitable age and experience who are thus interested in mining and allied work are allowed to enter at any time and to take any studies that they are able to master. They are permitted to remain as long as they wish, and are not under the operation of any college rules; but are expected to conduct themselves as good citizens and to attend to their selected work, or else withdraw from the institution.

The class room work usually commences at the beginning of a term and continues to its close, but if these students can profit by entering at other times and work can be arranged to meet their needs, there are no objections to this. In the majority of the laboratories the work can commence at any period, and part or the entire time of the student devoted to it as may seem best. Thus one having leisure at certain times of the year can take up different portions of the work in successive years as for instance during the Summer Terms.

The class room work specially available includes Crystallography, Mineralogy, Petrography, General Geology, Mining Geology, Ceramics, Ore Dressing and Preparation of Coal for the Market, Surveying, Mine Surveying, the different branches of Mining, Mine Gases, Explosives, First Aid to the Injured, Mine Rescue Work, Mine Accounts, Purchases and Supplies, Mine Economics, Mining Law and Management, the General Principles of Metallurgy, the Properties and Utilization of Fuels, Refractory Material and Alloys, the Metallurgy of Iron, Steel, Copper, Lead, Zinc, Nickel, and the Minor Metals, etc., etc.

In the laboratories there will be taught the adjustment, manipulation and use of the transit and other surveying instruments; the practical methods of discriminating and determining minerals, rocks, and fossils; Geological and Mine Surveying; Mapping and Field Geology; methods of Ore Dressing; "laying-out" of mine plants (including tipples, head-frames, shaft houses, mill buildings, fans, bents, chutes, etc.); processes of testing fans, operating drills and other mine machinery; mine gases, etc.; work in fuel testing, including the determination of moisture, vola-

tile hydrocarbons, fixed carbon and ash in coal, or proximate analysis; the determination of sulphur; tests to determine the effect of washing on coals; Gas Analysis, both of furnaces and flue gases; the determination of the efficiency of furnaces; Assaying, including the assay of gold, silver, and lead ores and furnace products by all known methods of assaying ores, fluxes, slags, and furnace products; and analysis for iron, copper, lead, zinc, and other substances met with in metallurgical work. Opportunities are also given for the carrying out tests on special processes of ore treatment, like the availability of the cyanide process for gold, etc.

All the School's work is freely available for use. No requirements will be made of the practical man who wishes to take advantage of the opportunities beyond that he shall be able to profit by the work that he wishes to take and that he shall attend to it. No matter what has been his past work, or what his age is, if he has the ambition, energy, and perseverance to rise, the School will be only too glad to help him in every way it can.

DAY, EVENING, AND SATURDAY SESSIONS

The School is in session daily from 8 or 8:30 A. M. to 5:30 or 6 P. M. The time from 12 to 1 or from 12:30 to 1:30 P. M., is set aside for the "Lunch Hour"; but in case of special or elective studies this hour may be scheduled for work, the student employing some other available time for his "Lunch Hour."

During the evenings, except Saturday, certain classes are held at convenient hours, generally from 7:30 to 9:00 or from 7:30 to 10:30, according as the work is class room or laboratory.

The subjects offered for 1911-1912 are the following which will be found more fully described in their appropriate places in this Bulletin.

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| Geol. 8. | General Geology.
Fall Term, 3 hours, 3 credits. Twice a week, 7:30 to 9 P. M.—Mr. Eaton. |
| Geol. 9. | Stratigraphical Geology.
Winter Term, 3 hours, 3 credits. Twice a week, 7:30 to 9 P. M.—Mr. Eaton. |
| Geol. 77, 78, 79. | Physical and Chemical Geology.
Fall Term, 3 hours, 3 credits. Twice a week, 7:30 each. Twice a week, 7:30 to 9 P. M. Dean Wadsworth. |
| Met. 107, 108, 109. | General Introduction to Metallurgy.
Fall, Winter, and Spring Terms, 3 hours, 3 credits each. Twice a week, 7:30 to 9 P. M.—Professor Goodale. |
| Met. 110, 111, 112. | Metallurgy of Iron and Steel.
Fall, Winter, and Spring Terms, 3 hours, 3 credits each. Twice a week, 7:30 to 9 P. M.—Professor Goodale. |

- Met. 113, 114, 115. General Metallurgy.
Fall, Winter, and Summer Terms, 3 hours, 3 credits each. Twice a week, 7:30 to 9 P. M.—Mr. Ray.
- Met. 116. Fire Assaying.
Fall Term, 6 hours, 2 credits. Twice a week, 7:30 to 10:30 P. M.—Mr. Ray.
- Met. 117. Wet Assaying.
Winter Term, 6 hours, 2 credits. Twice a week, 7:30 to 10:30 P. M.—Mr. Ray.
- Met. 118, 119. Metallurgical Laboratory Experiments.
Fall and Winter Terms, 6 hours, 2 credits. Twice a week, 7:30 to 10:30 P. M.—Professor Goodale.
- Mine 82. Elements of Mining.
Fall Term, 3 hours, 3 credits. Twice a week, 7:30 to 9 P. M.—Assistant Professor Meller.
- Mine 83. Methods of Coal Mining.
Winter Term, 3 hours, 3 credits. Twice a week, 7:30 to 9 P. M.—Mr. Haldeman.
- Mine. 84. Ore Mining Methods.
Spring Term, 3 hours, 3 credits. Twice a week, 7:30 to 9 P. M.—Assistant Professor Meller.
- M. Geol. 2. Principles of Mining Geology.
Fall Term, 3 hours, 3 credits. Twice a week, 7:30 to 9 P. M.—Dean Wadsworth.
- M. Geol. 106, 107. Mineral Wealth of North America.
Winter and Spring Terms, 3 hours, 3 credits. Twice a week, 7:30 to 9 P. M.—Mr. Leighton.

The instruction to be given during the evening will vary from term to term and from year to year according to the demand. The above courses are given for the most part to College and University graduates or to men of age and practical experience who desire to obtain technical knowledge in their professional branches; but who are unable to attend during the day time.

On Saturday Afternoons instruction is given in certain subjects that require daylight for their successful pursuit, like Mineralogy and Petrography. Saturday is, however, mainly taken up by laboratory and field work, like Field Geology; Surveying; Metallurgical, Mining, and Geological Excursions, etc.

SUMMER TERM

The instruction given during the Summer Term is considered as co-ordinate and equal to that of either of the three other terms. It is conducted upon the same basis and the same credits are given for its courses as for those of the other terms, and they (the credits) are to be equally used for a degree.

In many cases its courses are specially arranged to meet the needs of teachers who wish to obtain further theoretical and laboratory knowledge of the subjects taught. The Dean of the School and part of the regular instructors will be in charge of the work, and every effort will be made to have the grade of instruction fully equivalent, or above that of any of the preceeding three terms, and serve as a basis for use for teaching purposes in other schools.

The Summer Term is intended also to serve particularly for entering students in the place of the Fall Term, although the subjects in many cases vary from those of the Fall Term; especially those designed for teachers.

The following courses were announced for the Summer Term of 1911 and similar work is to be expected during the Summer Term of 1912:

II. GEOGRAPHY

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| Geog. 1. | Physical Geography 1. Physiography.
2 hours, 2 credits.—Dr. Ortmann or Mr. Eaton. |
| Geog. 4. | Advanced Physical Geography.
2 hours, 2 credits.—Dr. Ortmann or Mr. Eaton. |
| Geol. 7. | Economic Geography.
2 hours, 2 credits.—Dr. Ortmann or Mr. Eaton. |
| Geol. 10. | Paleogeography.
2 hours, 2 credits.—Dr. Ortmann or Mr. Eaton. |

III. GEOLOGY

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| Geol. 2. | General Geology.
3 hours, 3 credits.—Mr. Eaton. |
| Geol. 4. | Stratigraphical (Historical) Geology.
3 hours, 3 credits.—Dr. Eastman or Mr. Eaton. |
| Geol. 5. | Structural and Field Geology.
3 hours, 3 credits.—Mr. Eaton. |
| Geol. 10 or 11 or 12 | Physical and Chemical Geology: Earth Origin and Structure; or Vulcanism and Volcanoes; or Earthquakes and Earth Movements.
2 hours, 2 credits.—Dean Wadsworth. |
| Geol. 20. | Physiographic Geology.
2 hours, 2 credits.—Mr. Eaton. |
| Geol. 51. | Field Geology and Geological Surveying and Mapping.
6 hours, 2 credits.—Mr. Eaton. |
| Geol. 76. | Geological Literature.
7 hours, 3 credits.—Mr. Eaton. |

IV. METALLURGY AND ASSAYING

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| Met. 1. | General Metallurgy.
3 hours, 3 credits.—Mr. Ray. |
| Met. 7. | Metallography—Alloys.
2 hours, 2 credits.—Mr. Ray. |

Met. 10.	Metallurgical Calculations. 3 hours, 3 credits.—Mr. Ray.
Met. 22.	Metallurgy of Iron and Steel. 3 hours, 3 credits.—Mr. Ray.
Met. 27.	Metallurgy of Zinc. 2 hours, 2 credits.—Mr. Ray.
Met. 29.	Metallurgy of the Minor Metals. 2 hours, 2 credits.—Mr. Ray.
Met. 31.	Metallurgy of Gold, Silver, and Platinum. 2 to 4 hours, 2 to 4 credits.—Mr. Ray.
Met. 34.	Hydro-Metallurgy. 2 hours, 2 credits.—Mr. Ray.
Met. 42.	Metallurgical Designing. 3 to 36 hours, 1 to 12 credits.—Mr. Ray.
Met. 43.	Metallurgical Laboratory. 6 hours, 2 credits.—Mr. Ray.
Met. 73.	Fire Assaying. 6 hours, 2 credits.—Mr. Ray.
Met. 79.	Wet Assaying. 6 hours, 2 credits.—Mr. Ray.
Met. 101.	Reference Work on Current Literature. 6 to 12 hours, 2 to 4 credits.—Mr. Ray.
Met. 104.	Metallurgical Excursions. 6 to 12 hours, 2 to 4 credits.—Mr. Ray.

V. CRYSTALLOGRAPHY, MINERALOGY, AND LITHOLOGY

Min. 1.	Crystallography and Mineralogy. 8 hours, 4 credits.—Messrs. Eaton and Estabrook.
Min. 3.	Crystallography, Mineralogy, and Lithology. 14 hours, 6 credits.—Messrs. Eaton and Estabrook.
Min. 15.	Mineralogy and Lithology. 3 to 45 hours, 1 to 15 credits.—Messrs. Eaton and Estabrook.
Min. 27.	Blowpipe Analysis. 3 to 18 hours, 1 to 6 credits.—Messrs. Eaton and Estabrook.
Min. 30.	Mathematical Crystallography. 6 to 60 hours, 2 to 20 credits.—Mr. Eaton.

VI. MINING (COAL AND METAL MINING, QUARRYING)

Mine 1.	Elements of Mining. 3 hours, 3 credits.—Mr. Meller.
Mine 2.	Coal Mining Methods. 3 hours, 3 credits.—Mr. Meller.
Mine 7.	Coal Mining Machinery. 5 hours, 3 credits.—Mr. Meller.

- Mine 11. Ventilation, Lighting, etc.
2 hours, 2 credits.—Mr. Meller.
- Mine 13. Design of Ventilation Machinery.
4 hours, 2 credits.—Messrs. Meller and Zimmerman.
- Mine 14. Ore Mining Methods.
3 hours, 3 credits.—Mr. Meller.
- Mine 33. Mine Explosives—Their Care and Use.
2 hours, 2 credits.—Mr. Meller.
- Mine 40. Mine Rescue Training.
6 hours, 2 credits.—Mr. Meller.
- Mine 49. Exploitation and Development of Coal Properties.
7 hours, 3 credits.—Messrs. Meller and Zimmerman.
- Mine 64. Mining Laboratory and Design.
6 to 36 hours, 2 to 12 credits.—Messrs. Meller and Zimmerman.

VII. MINING ECONOMICS

- M. Ec. 1. Principles of Mining Economics.
2 hours, 2 credits.—Professor Beck.
- M. Ec. 4. Mine Management.
2 hours, 2 credits.—Mr. Meller.
- M. Ec. 7. Mining Corporation and Finance.
2 hours, 2 credits.—Professor Beck.
- M. Ec. 10. Mining Securities and Investments.
2 hours, 2 credits.—Professor Beck.
- M. Ec. 13. Mine Accounts.
2 to 6 hours, 2 credits.—Mr. Conrad.
- M. Ec. 16. Mine Labor Problems.
2 hours, 2 credits.—Mr. Conrad.
- M. Ec. 19. Mine Legislation.
2 hours, 2 credits.—Professor Beck.
- M. Ec. 22. The Mineral Industries.
2 hours, 2 credits.—Mr. Conrad.
- M. Ec. 24. The Iron and Steel Industries.
2 hours, 2 credits.—Mr. Conrad.

VIII. MINING (ECONOMIC) GEOLOGY

- M. Geol. 3. Elements of Mining (Economic) Geology.
3 hours, 3 credits.—Dean Wadsworth.
- M. Geol. 8. Metallites or Metalliferous Deposits.
2 hours, 2 credits.—Dean Wadsworth.
- M. Geol. 11. The Genesis of Mineral Deposits.
2 hours, 2 credits.—Dean Wadsworth.
- M. Geol. 21. Precious Stones or Gems—Their Origin, Occurrence,
Properties, Determination, and Uses.
2 hours, 2 credits.—Dean Wadsworth.

- M. Geol. 39. Copper Deposits.
2 hours, 2 credits.—Dean Wadsworth.
- M. Geol. 42. Gold Deposits.
2 hours, 2 credits.—Dean Wadsworth.
- M. Geol. 56. Building and Ornamental Stones.
3 hours, 3 credits.—Dean Wadsworth.

IX. MINING LAW

- Law. 1. Principles of Law and Introduction to Mining Law.
2 hours, 2 credits.—Mr. Conrad.
- Law. 2. General Mining Law.
2 hours, 2 credits.—Mr. Conrad.
- Law. 7. Advanced Mining Law.
2 hours, 2 credits.—Mr. Conrad.
- Law. 10. Law Relating to Oil and Gas.
2 hours, 2 credits.—Mr. Conrad.
- Law. 22. Law of Negligence and Personal Injuries in Mines.
2 hours, 2 credits.—Professor Beck.

X. MINING SURVEYING

- M. Sur. 2. Mining Surveying.
12 hours, 4 credits.—Messrs. Meller and Zimmerman.
- M. Sur. 5. Mining Surveying. Advanced Work.
12 hours, 4 credits.—Messrs. Meller and Zimmerman.

XI. ORE DRESSING AND COAL WASHING

- Ore. 1. Principles of Ore Dressing and Coal Washing.
3 hours, 3 credits.—Mr. Ray.
- Ore. 4. Gold and Silver Cyaniding and Milling.
2 hours, 2 credits.—Mr. Ray.
- Ore. 7. Coal Washing and Preparation for Market and Coking.
2 hours, 2 credits.—Mr. Ray.
- Ore. 10. Special Problems in Ore Dressing.
2 to 4 hours, 2 to 4 credits.—Mr. Ray.
- Ore. 60. Ore Dressing Trips or Visits of Inspection to Ore Dressing and Coal Washing Plants.
6 to 12 hours, 2 to 4 credits.—Mr. Ray.

XII. PALEOBOTANY

- F. Bot. 1. Paleobotany.
2 hours, 2 credits.—Mr. Jennings or Dean Wadsworth.

XIII. PALEONTOLOGY

- Pal. 1. Invertebrate Paleontology.
2 hours, 2 credits.—Dr. Eastman.

- Pal. 4. Invertebrate Paleontology. Advanced Course.
2 hours, 2 credits.—Dr. Eastman.
- Pal. 13. Invertebrate Paleontology. A brief Course for
teachers of Biology and General Geology.
3 hours, 3 credits.—Dr. Eastman.
- Pal. 14. Invertebrate Paleontology. A brief course upon the
Characteristic Fossils of the Principal Stratigraphic
Divisions for teachers of Historical Geology.
3 hours, 3 credits.—Dr. Eastman.
- Pal. 15. Vertebrate Paleontology.
2 hours, 2 credits.—Dr. Eastman.
- Pal. 27. Paleontological Laboratory—Invertebrata.
6 hours, 2 credits.—Dr. Eastman.
- Pal. 30. Paleontological Laboratory—Invertebrata. Advanced
Course.
6 hours, 2 credits.—Dr. Eastman.
- Pal. 39. Paleontological Laboratory, Vertebrata.
6 hours, 2 credits.—Dr. Eastman.

XIV. PETROGRAPHY.

- Pet. 1. Optical and Microscopical Mineralogy.
2 hours, 2 credits.—Mr. Eaton.
- Pet. 4. Microscopical Petrography.
2 hours, 2 credits.—Dean Wadsworth and Mr. Eaton.
- Pet. 10. Petrographical Laboratory.
6 hours, 2 credits.—Mr. Eaton.
- Pet. 13. Petrographical Laboratory. Advanced Work.
6 hours, 2 credits.—Dean Wadsworth and Mr. Eaton.
- Pet. 19. Petrographical Laboratory.
3 to 54 hours, 1 to 18 credits.—Mr. Eaton.
- Pet. 22. Petrographical Laboratory. Advanced Course.
3 to 54 hours, 1 to 18 credits.—Dean Wadsworth and
Mr. Eaton.

As the work of the School of Mines is to give instruction in all subjects included within the above 14 headings it is especially requested that if the list of subjects above given does not include the desired subject that the prospective student write to the Dean regarding it; for it is intended to provide instruction along all these lines.

The work of the other schools in session during the Summer Term is available as either required or elective.

REQUIREMENTS FOR DEGREES

No degree is given to a student who does not present an acceptable thesis and who has not been enrolled as a student in the School of Mines for at least one year of three terms, which need not, however, be

consecutive, *e. g.*, a teacher who was only able to be present during Summer Terms could graduate in three Summer Terms if he was otherwise prepared and had suitable credits.

As explained in a previous section students required in 1911 and previous years under the regulations prior to 1908, 144 semester credits to graduate; in the semester plan under the new regulations 184 credits each, each credit being of equal value to each credit of the preceding 144. Under the term system each student to graduate requires 276 credits or the exact equivalent of the 184 semester credits.

While on the average 23 credits are required each term, for 12 terms, each student's schedule can be varied each term to suit his special conditions; health, time, natural ability, etc.; *i. e.*, each individual is considered and his schedule is adapted to him and not to the other members of his class. Since a student generally accomplishes more work in the later part of his course than in the earlier years when he is unfamiliar with university methods, it is usually advisable for him to take less than 23 credits during the first year, and more credits than 23 during the later years. Should the work be too hard, deficient credits can be made up by practical work or by increasing the number of terms. All this the elective system readily provides for.

The basis for graduation of the different classes in the respective units is as follows:

Class of

1910	144 Semester Credits,	+ No Term Credits	
1911	108 Semester Credits,	+ 54 Term Credits	= 144 Semester Credits
1912	92 Semester Credits,	+ 138 Term Credits	= 184 Semester or 276 Term Credits
1913	46 Semester Credits,	+ 207 Term Credits	= 276 Term Credits
1914	No Semester Credits,	+ 276 Term Credits	
Subsequent Classes No Semester Credits, 276 Term Credits			

BACHELOR OF SCIENCE DEGREES

The candidate for a *Bachelor of Science Degree* is to select as his major or subject title for his degree one of the following subjects:

Ceramics,	Memetallites,
Geography,	Mining Law,
Geology,	Ore Dressing,
Inorganic Geology,	Electro-Metallurgy,
Organic Geology,	Hydro-Metallurgy,
Metallurgy,	Assaying,
Ferrous Metallurgy,	Mineralogy,
Nonferrous Metallurgy,	Mining,
Mining Economics,	Coal Washing,
Coal Mining,	Paleontology,
Metal Mining,	Paleozoölogy,
Mining (Economic) Geology,	Paleobotany,
Metallites,	Petrography.

Systematic advisory courses are laid out in most of these subjects as an aid to the student in selecting his electives. These advisory courses are to be found in the back part of this Bulletin of the School of Mines.

FIXED STUDIES FOR A BACHELOR OF SCIENCE DEGREE AND FOR THE SHORT COURSES

NUMBER	SUBJECT	TERM	HRS.	CDS.
Mat. 6	Spherical Trigonometry	Spring	2	2
Sur. 1	Surveying	Spring	5	3
Ch. 1	General Chemistry	Fall	8	4
Ch. 2	General Chemistry	Winter	8	4
Dr. 1	Mechanical Drawing	Fall	3	1
Dr. 2	Mechanical Drawing	Winter	3	1
Dr. 3	Mechanical Drawing	Spring	6	2
Min. 3	Crystallography and Mineralogy	Fall or Summer	14	6
Min. 4	Mineralogy and Lithology	Winter	14	6
Min. 5	Mineralogy and Lithology	Spring	14	6
Geol. 3	General Geology	Fall or Summer	3	3
Geol. 4	Stratigraphical (Historical) Geology	Winter or Spring or Summer	3	3
Met. 1	Principles of Metallurgy	Fall or Summer	3	3
M. Geol. 1.	The Elements of Mining Geology	Spring or Summer	3	3
Ore. 1	The Principles of Ore Dress- ing and Coal Washing	Fall or Summer	3	3
Mine. 1	The Principles of Mining	Fall or Summer	3	3
Total Term Credits			53	

The fixed studies for a Bachelor of Science Degree amount to 53 Term Credits. Further, the candidate must have completed 45 more Term Credits in the subject selected for his degree title above given, exclusive of the "Practical (Co-operative) Work." He must also further obtain 178 Term Credits including the "Practical (Co-operative) Work," if any, or a total of 276 credits for graduation.

A BACHELOR OF SCIENCE DEGREE

Fixed Term Credits	53
Elective Degree Term Credits	45
Elective (including Practical Work) Term Credits	178
Total Term Credits required for Bachelor of Science Degree.....	276

ENGINEERING DEGREES

The Engineering Degrees given are: Ceramic Engineer (Cer. E.), Geological Engineer (G. E.), Metallurgical Engineer (Met. E.), Engineer of Mines (Mining Engineer) (E. M.).

For systematic advisory courses leading to these degrees the student is referred to the back part of this Bulletin.

FIXED STUDIES FOR AN ENGINEERING DEGREE

NUMBER	SUBJECT	TERM	HRS. CDS.	
Mat. 2	Advanced Algebra	Fall	5	5
Mat. 6	Trigonometry, Spherical	Spring	2	2
Mat. 7	Analytical Geometry	Winter	2	2
Mat. 8	Analytical Geometry	Spring	2	2
Mat. 9	Calculus	Fall or Summer	4	4
Mat. 10	Calculus	Winter or Spring	4	4
Mec. 1	Analytic Mechanics	Summer	5	5
Mec. 2	Mechanics of Materials	Fall or Winter	5	5
Mec. 3	Mechanical Laboratory	Fall or Winter	6	2
Mec. 5	Hydromechanics and Hydraulics	Spring or Summer	4	4
Mec. 6	Hydraulic Laboratory	Spring or Summer	3	1
Sur. 1	Surveying	Spring	5	3
Ch. 1	General Chemistry	Fall	8	4
Ch. 2	General Chemistry	Winter	8	4
Dr. 1	Mechanical Drawing	Fall	3	1
Dr. 2	Mechanical Drawing	Winter	3	1
Dr. 3	Mechanical Drawing	Spring	6	2
Min. 3	Crystallography and Mineralogy	Fall or Summer	14	6
Min. 4	Mineralogy and Lithology	Winter	14	6
Min. 5	Mineralogy and Lithology	Spring	14	6
Geo. 3	General Geology	Fall or Summer	3	3
Geol. 4	Stratigraphical (Historical) Geology	Winter or Spring or Summer	3	3
Met. 1	The Principles of Metallurgy	Spring or Summer	3	3
M. Geol. 1.	The Principles of Mining Geology	Spring or Summer	3	3
Ore. 1	Principles of Ore Dress- ing and Coal Washing	Fall or Summer	3	3
Mine. 1	The Principles of Mining	Fall or Summer	3	3
Total Term Credits			87	

The fixed studies for an Engineering Degree amount to 87 Term Credits. As in the Bachelor of Science Degree 45 Term Credits are to be elected in the subject in which the degree is sought exclusive of the

"Practical (Co-operative) Work." This leaves 144 Term Credits to be obtained by election including the "Practical (Co-operative) Work" if any is taken, or 276 Terms Credit for Graduation.

AN ENGINEERING DEGREE

Fixed Term Credits	87
Elective Degree Term Credits	45
Elective (including Practical Work) Term Credits	144
Total Term Credits required for an Engineering Degree	276

EXPENSES

PER TERM

Matriculation Fee (at entrance only)	\$ 5.00
Tuition, Fall Term	40.00
Tuition, Other Terms	35.00
Tuition per year, if paid in advance	105.00
Tuition for each Evening Course	10.00
Tuition for each Saturday Afternoon Course	10.00
Assaying Fire, 6 hours per week	10.00
Assaying, Wet, 6 hours per week	5.00
Metallurgical Laboratory, 6 hours per week	5.00
Mineralogical Laboratory, 12 hours per week	10.00
Mining Surveying, 12 hours per week	5.00
Mining Surveying, 6 hours per week	2.50
Mining Surveying, Summer Term	15.00
Breakage Deposit for all students taking laboratory work	10.00
Diploma	5.00

The charge when less or more hours than those above specified are taken is 50 cents per term hour, *i. e.*, one hour's work in the laboratory each week for the term when the course costs \$5.00 per term. The charge per term hour is \$1.00 when the course costs \$10.00 per term.

The tuition fee for students taking one or a few subjects only during the regular day sessions is \$3.00 per term for each credit hour.

The amount charged for tuition includes an Athletic Fee, which entitles students to free admission to the athletic events under the control of the General Athletic Committee of the University.

WORK IN THE SCHOOL OF MINES

The titles of the subjects offered in the School of Mines are given in the following pages. The subjects are arranged in groups to which reference is made in the schedules of studies under the following abbreviations:

I.	Ceramics: Brick, Pottery, Glass, Cement, Concrete.....	Cer.
II.	Geography: Physical, Economic, Paleogeography	Geog.
III.	Geology: Inorganic, Organic	Geol.
IV.	Metallurgy: Ferrous, Non-Ferrous, Assaying	Met.
V.	Crystallography, Mineralogy, and Lithology	Min.
VI.	Mining: Coal and Metal Mining, Quarrying, Engineering..	Mine.
VII.	Mining Economics: Labor, Management, Accounts	M. Geol.
VIII.	Mining Geology: Metellites, Memetallites	M. Geol.
IX.	Mining Law: Coal, Metal, Oil, Gas	Law.
X.	Mining Surveying	M. Sur.
XI.	Ore Dressing and Coal Washing	Ore.
XII.	Paleobotany or Fossil Botany	F. Bot.
XIII.	Paleontology or Paleozoölogy or Fossil Zoölogy	Pal.
XIV.	Petrography.	

In the list of subjects the terms in which each subject is given are arranged as can best be told in advance to enable students to enter during any term of the school year. When the subject is announced as given in one or the other of two or more terms the instruction may be given in all these terms each year or in one only or in a different term according to the number of students asking for it and to various other conditions. As soon as experience with the four term system shall show in which term each subject should be taught, the present temporary arrangement will be changed to a permanent one.

I. CERAMICS

UNDERGRADUATE WORK

ASSISTANT PROFESSOR SILVERMAN AND MR. LEIGHTON

The term Cermics is used here in its broadest sense to include not only brick, tile, terra cotta, pottery, and porcelain manufactures, but also limes, plasters, cements, concretes, glass making, etc.

The intention in the instruction in Ceramics is to train the student thoroughly in the principles or science of the subject, and then give him sufficient practical experience in the application of those principles so he can assimilate and understand them.

Cér. 1. Clay Testing.

Preparation required: Phy. 1 or 11; Ch. 1, 2, 3; Geol. 1, 2 or 3.

Taken with M. Geol. 14.

Fall Term, 2 to 6 hours, 2 credits.

This course includes the usual tests for clay in regard to their fitness for various uses, by means of a specially constructed furnace and other methods.

Cer. 2, 3. Clay Mining and Manufactures.

Preparation required: Cer. 1; Ch. 9.

Taken with Ch. 10, 11; M. Geol. 15, 16.

Winter and Spring Terms, 2 hours, 2 credits each.

Cer. 4, 5, 6. Manufacture, Properties, Tests, and Uses of Bricks, Tiles, Terra Cotta, etc.

Preparation required: Cer. 1, 2, 3.

Fall, Winter, and Spring Terms, 2 to 6 hours, 2 credits each.

Cer. 7, 8, 9. Manufacture, Properties, Tests, and Uses of Limes, Plasters, and Cements.

Preparation required: Cer. 1, 2, 3.

Taken with M. Geol. 17, 18, 19; Ch. 12, 13, 14.

Fall, Winter, and Spring Terms, 2 to 6 hours, 2 credits each.

Cer. 10, 11, 12. Glazes, Enamels, and Colors.

Preparation required: Cer. 1, 2, 3.

Taken with M. Geol. 20.

Fall, Winter, and Spring Terms, 2 to 6 hours, 2 credits each.

Cer. 13, 14, 15. Manufacture of Glass.

Preparation required: Cer. 1, 2, 3; Ch. 9, 10, 11.

Taken with Ch. 12, 13, 14.

Fall, Winter, and Spring Terms, 2 to 6 hours, 2 credits.

Subjects Cer. 13, 14, and 15 consist of 2 lectures per week on raw materials, their occurrence, preparation and chemical analysis; batches, clays and their use in construction of pots, crucibles, and tanks; types of furnaces; types of glass and possible variations from them; production of colored glass (pot and decorative); etching and sand-blasting; annealing, flashing and casing; cracking, grinding, cutting, polishing, drilling and perforating; chemical analysis of glass; physical properties together with rapid physical test as check on chemical composition. Occasional visits are made to various glass manufacturing establishments.

Cer. 16, 17, 18. Manufacture, Properties, Tests, and Uses of Cements.

Preparation required: Cer. 1, 2, 3, 7, 8, 9.

Fall, Winter, and Spring Terms, 2 to 6 hours, 2 credits each.

Cer. 19, 20, 21. Concrete—Its Properties, Tests, and Uses, and Concrete construction.

Preparation required: Cer. 1, 2, 3, 7, 8, 9; Mec. 2, 4.

Taken with Cer. 16, 17, 18; C. E. 7, 8.

Fall, Winter, and Spring Terms, 2 to 6 hours, 2 credits each.

Cer. 22, 23, 24. Manufacture and Properties of Pottery and Porcelain.

Preparation required: Cer. 1, 2, 3.

Taken with Cer. 10, 11, 12.

Fall, Winter, and Spring Terms, 2 to 6 hours, 2 credits each.

Cer. 25. Manufacture, Properties, Tests, and Uses of Fire Brick.

Preparation required: Cer. 1, 2, 3, 4, 5, 6.

Fall Term, 2 to 6 hours, 2 credits each.

Cer. 26. Manufacture of Limes, Plasters, Sand-Lime-Brick, etc.

Preparation required: Cer. 1, 2, 3, 7, 8, 9.

Winter Term, 2 to 6 hours, 2 credits each.

Cer. 27. Ceramic Construction.

Preparation required: Cer. 22, 23, 24.

Spring Term, 2 to 6 hours, 2 credits each.

Cer. 28, 29, 30. Brick and Terra Cotta Construction.

Preparation required: Cer. 1, 2, 3, 4, 5, 6, 7, 8, 9.

Taken with C. E. 7, 8.

Fall, Winter, and Spring Terms, 2 to 6 hours, 2 credits.

Cer. 31, 32, 33. Ceramic Calculations.

Taken with Cer. 10, 11, 12, or 13, 14, 15, or 22, 23, 24, or 57, 58, 59.

Fall, Winter, and Spring Terms, 2 to 6 hours, 2 credits each.

Cer. 34, 35, 36. Ceramic Laboratory.

Taken with Cer. 1, 2, 3.

Fall, Winter, and Spring Terms, 6 hours, 2 credits each.

Cer. 37, 38, 39. Ceramic Laboratory.

Preparation required: Cer. 34, 35, 36.

Taken with Cer. 4, 5, 6, or 7, 8, 9, 10, 11, 12, or 13, 14, or 22, 23, 24.

Fall, Winter, and Spring Terms, 6 hours, 2 credits each.

Cer. 40, 41, 42. Ceramic Laboratory.

Preparation required: Cer. 37, 38, 39.

Taken with Cer. 16, 17, 18, or 19, 20, 21, or 25, 26, 27, or 28, 29, 30.

Fall, Winter, and Spring Terms, 6 hours, 2 credits each.

Cer. 43, 44, 45. Ceramic Laboratory.

Taken with Cer. 34, 35, 36.

Fall, Winter, and Spring Terms, 3 to 45 hours, 1 to 15 credits each.

Cer. 46, 47, 48. Ceramic Laboratory.

Taken with Cer. 37, 38, 39.

Fall, Winter, and Spring Terms, 3 to 45 hours, 1 to 15 credits each.

Cer. 49, 50, 51. Ceramic Laboratory.

Taken with Cer. 40, 41, 42.

Spring Term, 3 to 45 hours, 1 to 15 credits each.

Cer. 52, 53, 54. Laboratory Work in Glass Making and Manipulation.

Taken with Cer. 13, 14, 15.

Fall, Winter, and Spring Terms, 3 to 45 hours, 1 to 15 credits.

Cer. 55, 56, 57. Laboratory Work in Glass Making and Manipulation.

Preparation required: Cer. 52, 53, 54.

Fall, Winter, and Spring Terms, 3 to 45 hours, 1 to 15 credits each.

Cer. 58, 59, 60. Ceramic Chemistry.

Preparation required: Phy. 1 or 11; Ch. 1, 2, 8; Geol. 3 and 4; Min. 3, 4, 5; M. Geol. 1.

To be taken with Ch. 9, 10, 11.

Fall, Winter, and Spring Terms, 6 to 48 hours, 2 to 16 credits each.

Cer. 61, 62, 63. Ceramic Chemistry.

Preparation required: Cer. 58, 59, 60.

Fall, Winter, and Spring Terms, 6 to 48 hours, 2 to 16 credits each.

- Cer. 64, 65, 66. Ceramic Chemistry.
Preparation required: Cer. 61, 62, 63.
Fall, Winter, and Spring Terms, 6 to 48 hours, 2 to 16 credits each.
- Cer. 67, 68, 69, 70. Practical Work in Ceramics.
Preparation required: Cer. 1, 2, 3, at least.
13 weeks, 18 credits each.
- Cer. 71, 72, 73, 74. Practical Work in the Manufacture of Brick, Tile, Terra Cotta, etc.
Preparation required: Cer. 4, 5, 6.
13 weeks, 18 credits each.
- Cer. 75, 76, 77, 78. Practical Work in Lime, Plasters, and Cements.
Preparation required: Cer. 7, 8, 9.
13 weeks, 18 credits each.
- Cer. 79, 80, 81, 82. Practical Work in Cement Manufacture.
Preparation required: Cer. 16, 17, 18.
13 weeks, 18 credits each.
- Cer. 83, 84, 85, 86. Practical Work in Concrete Construction.
Preparation required: Cer. 19, 20, 21.
13 weeks, 18 credits each.
- Cer. 87, 88, 89, 90. Practical Work in Glass Making.
Preparation required: Cer. 13, 14, 15.
13 weeks, 18 credits each.
- Cer. 91, 92, 93, 94. Practical Work in Ceramic Chemistry.
Preparation required: Cer. 57, 58, 59.
13 weeks, 18 credits each.

GRADUATE WORK

ASSISTANT PROFESSOR SILVERMAN AND MR. LEIGHTON

These subjects can be taken during one, two, three, or four terms, and for as many years as may be necessary. As a matter of convenience in keeping the records each term is given a separate number. The student can take from 3 to 60 hours, receiving from 1 to 20 credits according to the time taken and work accomplished.

- Cer. 301, 302, 303, 304. Research Work in Clay Testing.
Preparation required: Cer. 1.
- Cer. 305, 306, 307, 308. Research Work in Clay Working.
Preparation required: Cer. 2, 3.
- Cer. 309, 310, 311, 312. Research Work on the Manufacture of Brick, Tile, Terra Cotta, etc.
Preparation required: Cer. 4, 5, 6.
- Cer. 313, 314, 315, 316. Research Work in Cement Manufacture, Properties and Uses.
Preparation required: Cer. 16, 17, 18.

Cer. 317, 318, 319, 320. Research Work in Concrete Manufacture, Properties, and Uses.

Preparation required: Cer. 19, 20, 21.

Cer. 321, 322, 323, 324. Research Work in the Manufacture of Limes, Plasters, Sand-Lime-Bricks, etc.

Preparation required: Cer. 26.

Cer. 325, 326, 327, 328. Research Work in the Manufacture, Properties, and Uses of Paving Brick.

Preparation required: Cer. 28, 29, 30.

Cer. 329, 330, 331, 332. Research Work in the Manufacture, Properties, and Uses of Slag Brick.

Preparation required: Cer. 28, 29, 30.

Cer. 333, 334, 335, 336. Research Work in the Manufacture, Properties, and Uses of Ornamental Brick.

Preparation required: Cer. 28, 29, 30.

Cer. 337, 338, 339, 340. Research Work in the Manufacture, Properties, and Uses of Fire Brick.

Preparation required: Cer. 25.

Cer. 341, 342, 343, 344. Research Work in Glass Making.

Preparation required: Cer. 13, 14, 15.

Cer. 345, 346, 347, 348. Research Work in Ceramics.

Preparation required: Cer. 27.

Cer. 349, 350, 351, 352. Research Work in the Manufacture of Pottery and Porcelain.

Preparation required: Cer. 22, 23, 24.

Cer. 353, 354, 355, 356. Research Work upon Glazes, Enamels, and Colors.

Preparation required: Cer. 10, 11, 12.

Cer. 357, 358, 359, 360. Research Work in Ceramic Chemistry.

Preparation required: Cer. 57, 58, 59, 60, 61, 62, 63, 64, 65.

Cer. 361, 362, 363, 364. Research Work upon the History of Ceramics.

Preparation required: Cer. 22, 23, 24.

Cer. 365, 366, 367, 368. Research Work upon Ceramic Education.

Preparation required: Cer. 22, 23, 24.

For the present at least the Undergraduate Subjects Cer. 1 to 103 are also intended for Graduates. See Graduate School, Part IX, University catalog.

II. GEOGRAPHY

UNDERGRADUATE WORK

DR. ORTMANN.

Geog. 1. Physical Geography I. (Physiography).

Fall or Summer Term, 2 hours, 2 credits.

Physical Geography of the Land. This course will be largely descriptive, making the student acquainted with the chief characters of the

land's surface, and giving their scientific terminology. The forms of the land, as plains, plateaus, mountains, rivers, valleys, and shore lines will be discussed, describing their different development as we find it at the present time.

Text book: Davis, *Physical Geography*; Simmons, *Physiography for Beginners*.

Geog. 2. Physical Geography II. (Oceanography).

Winter Term, 2 hours, 2 credits.

Preparation required: Geog. 1.

Physical Geography of the Sea. Descriptive treatment of the chief features of the seas, their divisions and classifications, their depth, and the characteristics of the water, temperature, currents, etc.

Text book: Davis, *Physical Geography*.

Geog. 3. Physical Geography III (Climatology).

Preparation required: Geog. 1, 2.

Spring Term, 2 hours, 2 credits.

Physical Geography of the Air. Principal physical conditions of the atmosphere, chiefly with regard to temperature, precipitation, and the general circulation of the air currents.

Text book: Davis, *Physical Geography*.

Geog. 4. Advanced Physical Geography, I.

Preparation required: Geog. 1, 2, 3; Geol. 3, 4.

Fall or Summer Term, 2 hours, 2 credits.

This course will treat of the causes and the origin of the existing land forms. It will be shown, how the land is formed, and how air, water, ice, etc., act upon it, changing its original condition by removing material, transporting it, and finally bringing it to sea level.

Text book: Salisbury, *Physiography*.

Geog. 5. Advanced Physical Geography, II.

Preparation required: Geog. 1, 2, 3, 4.

Winter Term, 2 hours, 2 credits.

The physical processes going on in the ocean will be treated, chiefly with regard to the further transport and deposition (sedimentation) of the material brought from the land.

Text book: Salisbury, *Physiography*.

Geog. 6. Advanced Physical Geography III (Meteorology).

Preparation required: Geog. 1, 2, 3.

Spring Term, 2 hours, 2 credits.

Continuation of Geog. 3, treating of the more special and local processes in the air, which regulate the weather. The chief types of the latter will be discussed, with instruction in meteorological observation and weather forecasting.

Geog. 7, 8, 9. Economic Geography.

Preparation required: Geog. 1, 2, 3, 4, 5; Geol. 3, 4.

Fall, Winter, and Spring or Summer Terms, 2 hours, 2 credits each term.

In the courses 7 to 9, the effect of the facts and processes of Physical

Geography upon mankind, its distribution, civilization, and upon the development and the possibilities of the various industries will be discussed. Chief attention will be directed to the mineral products of the earth and their geographical distribution.

Geog. 10, 11, 12. Paleogeography.

Preparation required: Geog. 1, 2, 3, 4, 5; Geol. 3, 4.

Fall, Winter, and Spring or Summer Terms, 3 hours, 3 credits each term.

Geog. 10, 11, 12 treat of the development of the "Face of the Earth". An account will be given of the history of the earth with reference to the development of the external features of the distribution of land and water: It will be attempted to trace the origin and the changes of the continent and oceans through the different geological ages up to the present conditions.

Text book: Suess, *Face of the Earth* (translated by Sollas).

GRADUATE WORK

The subjects numbered below can be taken for the Fall, Winter, Spring, or Summer Terms, and for as many years as necessary. As a matter of convenience in keeping the records each term is given a separate number.

A student can take any of these subjects from 3 to 60 hours a week, with from 1 to 20 credits a term.

Geog. 301, 302, 303, 304. Research Work in Physiography.

Preparation required: Geog. 1, 2, 3, 4, 5, 6, 10, 11, 12; Geol. 3, 4.

Geog. 305, 306, 307, 308. Research Work in Oceanography.

Preparation required: Geog. 1, 2, 3, 4, 5, 6; Geol. 3, 4.

Geog. 309, 310, 311, 312. Research Work in Climatology and Meteorology

Preparation required: Geog. 1, 2, 3, 4, 5, 6; Geol. 3, 4.

Geog. 313, 314, 315, 316. Research Work in Economic Geography.

Preparation required: Geog. 1, 2, 3, 4, 5, 6, 7, 8, 9; Geol. 3, 4.

Geog. 317, 318, 319, 320. Research Work in Paleogeography.

Preparation required: Geog. 1, 2, 3, 4, 5, 6, 10, 11, 12; Geol. 3, 4.

Geog. 4, 5, 6, 7, 8, 9, 10, 11, 12 are also intended for Graduates.

III. GEOLOGY

UNDERGRADUATE WORK

DEAN WADSWORTH, DR. EASTMAN, AND MESSRS. EATON, LEIGHTON, AND JENNINGS.

The subjects in Geology are developed with special reference to the needs of the prospector, the explorer, the teacher, the engineer, the petrographer, the geologist, the miner, the quarryman, and all others who desire to understand the sequence and the structural relations that rock-masses bear to one another and to the deposits of economic value that

they contain. The courses are designed to treat of the origin, stratigraphic succession, and alteration of the rocks, sedimentation, jointing, faulting, cleavage, mountain building, volcanic and earthquake action, eruptive rocks, metamorphism, and crystalline schists; the action of air, of surface and underground waters, and other agencies of erosion; and finally the phenomena of organic matter. All these subjects are considered in their relations to the problems that confront the mining geologist, miner, and quarryman. The student is brought in contact constantly with the various problems that arise in practical work and the methods of their solution.

These subjects extend and continue the subject matter that is more briefly touched upon in Mineralogy and Petrography. The instruction is given by lectures, laboratory, and field work and by quizzes based upon the lectures and assigned reading in various text books.

Geol. 1. General Geology.

Preparation required: Min. 1.

Fall or Winter and Spring or Summer Terms, 3 hours, 3 credits.

MR. EATON

Under this head instruction is given by means of text book (Scott's *Introduction to Geology*) and lectures on the general principles of geological science, including the probable origin and structure of the earth; volcanic and earthquake action; the destructive and reconstructive action of air and water, both surface and subterranean; the important earth-building minerals and rocks, their alterations and accidents; geological topography, etc. This course is intended primarily for the students of the Schools of Liberal Arts and Education and those in the courses in Engineering. When necessary it can be substituted for Geol. 3.

Geol. 2. General Geology.

Summer Term, 3 hours, 3 credits.

MR. EATON

This course is similar to Geol. 1, and is intended for students who have had no special preparation to enable them to understand the subject, and many others who attend the summer term. For those who show good ability in it, it can be substituted for Geol. 1 or Geol. 3.

Geol. 3. General Geology.

Taken with Min. 1; Ch. 1.

Fall Term, 3 hours, 3 credits.

MR. EATON

This course is similar to Geol. 1, and is intended for the students of the School of Mines. It is preparatory to the subsequent courses in Geology and to those in Paleozoölogy and Paleobotany. It is required of all the students of the School of Mines.

Geol. 4. Stratigraphical (Historical) Geology.

Preparation required: Geol. 1 or 2, or 3 or 8.

Winter, or Spring, or Summer Term, 3 hours, 3 credits.

DR. EASTMAN OR MR. EATON.

This course is open to properly qualified students of the Schools of Liberal Arts, Engineering, and Education, and is required of all can-

didates for a degree in the School of Mines. The object of the course is to familiarize the student with the ancient life history of the earth, the lithological structure of the successive sedimentary formations, their characteristic fossils, origin, their order of superposition, their upheavals and accompanying eruptive phenomena, their distribution in time and space, and such other facts as the student of Stratigraphy needs to learn. The principles of correlation of contemporary (homotaxical) deposits by means of their faunal contents will also be elucidated.

Geol. 5. Structural and Field Geology.

Preparation required: Geol. 1 or 2 or 3 or 8, and 4 or 9.

• Fall or Summer Term, 2 hours, 2 credits.

MR. EATON

This course is intended to cover the general principles of Geology in their applications to Engineering and Field Geology, and should be taken by all students of Field Geology. Geol. 3, 4 and 5 with 16 make a fair geological course for those who do not intend to specialize in that subject.

Geol. 6. Botanical Geology.

Preceded by or taken with Geol. 1 or 2, or 3 or 8.

Fall Term, 3 hours, 3 credits.

MR. JENNINGS

The aim of this course is to give the student an acquaintance with the essential features of the evolutionary development of the plant kingdom, laying special emphasis upon the evidences of such a development as afforded by fossils and referring the various plants and the various stages of development to their respective places in geological time and classification, leading finally to the modern flora. This course is preliminary to the successful study of Paleobotany and should be taken by all students of Stratigraphical Geology.

Geol. 7. Zoölogical Geology.

Preparation required: Geol. 1 or 2 or 3 or 8, and preceded by or taken with Geol. 4 or 9.

Winter Term, 3 hours, 3 credits.

DR. EASTMAN

Its aim is similar to that of the preceding course, being intended to acquaint the student in a general way with the evolutionary history of animal forms, the dominant types existing at successive periods from the oldest fossiliferous rocks onward to the present day, and the progressive changes in the animal kingdom to which the geological record bears witness, with gradual approximation to the modern fauna. Some account will be given of the structure and distinguishing characters of the more important groups of fossil organisms, their distribution in point of time and space, and their systematic relationships. This course serves as an introduction to a more detailed study of Paleozoölogy and should be taken by all students or areal and Stratigraphic Geology.

Geol. 8. General Geology.

Fall Term, 3 hours, 3 credits.

MR. EATON

This course is given in the evening usually from 7:30 to 9:00 P. M. twice a week. It is intended to cover the general principles of Geology and to be the equivalent of Geol. 1 or 2, or 3. It may be substituted for either. It is for college or university graduates whose previous geological training has been limited and also for other persons who wish to obtain a knowledge of that science, but who are unable to avail themselves of the day courses.

Geol. 9. Stratigraphical Geology.

Preparation required: Geol. 1 or 2 or 3 or 8.

Winter Term, 3 hours, 3 credits.

MR. EATON

This course is given in the evening and is a continuation of Geol. 8. It is the equivalent of Geol. 4 and can be substituted for it. The instruction is given from 7:30 to 9:00 P. M. twice a week.

Geol. 10. Physical and Chemical Geology,—Earth Origin and Structure.

Preparation required: Geol. 1 or 2 or 3 or 8; and Geol. 4 or 9.

Fall or Summer Term, 2 hours, 2 credits.

Taken with Pet. 1, 10.

DEAN WADSWORTH

This course is introductory to a general course of instruction in Geology and Mining Geology, given by the Dean and extending over a period of three years. It is intended expressly to prepare men for thorough and accurate study of the various economic deposits, and to fit them to become Mining Geologists or Geological Engineers. Geol. 10 will treat in the main of the origin of the earth—the Nebular and Planetesimal Hypotheses, the earth's interior heat and structure, and the laws under which the earth has developed and its useful deposits have been formed. The work in Geol. 10, 11, 12 will be carried on by means of text-books, lectures, discussions, and collateral reading.

Geol. 11. Physical and Chemical Geology,—Vulcanism and Volcanoes.

Preparation required: Geol. 10; Pet. 1, 10.

Taken with Pet. 2, 11.

Winter Term, 2 hours, 2 credits.

DEAN WADSWORTH

This course is a direct continuation of Geol. 10, and will treat of the manifestations of the earth's interior in the volcanic phenomena of the different geological ages, and in recent times. It is intended to deal with fissure eruptions as well as with the more common volcanic types, hot water action, etc.

Geol. 12. Physical and Chemical Geology,—Earthquakes, Seismology, and Earth Movements.

Preparation required: Geol. 11, Pet. 2, 11.

Taken with Pet. 3, 12.

Spring Term, 2 hours, 2 credits.

DEAN WADSWORTH

This course is a direct continuation of, and may even include part of Geol. 11, if that work is not fully completed during the preceding term. This work includes earthquake phenomena, and other earth movements, particularly in their relations to vein phenomena, crust folding, etc. In Geol. 10, 11, 12 it is purposed to treat of the fundamental phenomena and principles that underlie the subjects of metamorphism or rock alteration and the genesis of mineral deposits. Students taking these courses are pre-supposed to be well grounded in Physics (particularly in Heat), Chemistry (including Physical Chemistry), Descriptive Astronomy, and the preceding Mineralogy and Geology. Owing to Geol. 10 being taught during the Summer Term teachers and mature students who can not attend during the Fall and Spring Terms will be allowed to take this work during the Summer Term if they can carry it on understandingly.

Geol. 13, 14, 15. Physical and Chemical Geology,—Metamorphism or Mineral and Rock Alteration.

Preparation required: Geol. 10, 11, 12 or 5 and 16; Pet. 1, 2, 3, 10, 11, 12.

Taken with Pet. 4, 5, 6, 13, 14, 15.

Winter, Fall, and Spring, or Summer Terms, 2 hours, 2 credits each.

DEAN WADSWORTH

Geology 13, 14, 15 are intended to continue the work of Geol. 10, 11, 12 and to apply the principles laid down in those courses. The work will cover essentially the ground of Van Hise's Treatise on Metamorphism and Clark's Geochemistry, which will be used as a basis for lectures and discussion. Collateral reading will also be required and an attempt made to bring the subject up to date. The above work is essential to a proper understanding of M. Geol. 11, 12, 13 or the Genesis of Mineral Deposits. Therefore, Geol. 10, 11, 12, 13, 14, 15 and M. Geol. 11, 12, 13 form a connected whole and should be taken by every student of Geology and Mining Geology. They will also be of great value to students of Mining if they can spare sufficient time for this work.

Geol. 16. Physical and Chemical Geology.

Preparation required: Min. 3, 4, 5; Geol. 1 or 2, or 3 or 8, and 4 or 9. Spring or Summer Term, 3 hours, 3 credits.

DEAN WADSWORTH

This course is arranged to cover the general principles of Geology in their applications in Physical, Chemical, Stratigraphical, Engineering, and Field Geology, and to supplement Geol. 1, 2 or 3, and 4 or 9.

This work is intended for students who wish a good knowledge of Geology, but do not wish to specialize further in that subject, *i. e.*, those who wish the knowledge for its use and practical applications in their other subsequent work. This course is especially arranged for mining, engineering, and metallurgical students, teachers and others who can give only one term to the more advanced phases of geological science. The instruction will be by the use of text, lectures, collateral reading, and quizzes. It will cover in a short course an abstract of

much of the material given in Geol. 10, 11, 12, and in special cases of men who show a good understanding of Geol. 16 and who are not seeking a geological degree it can be substituted with Geol. 5 for Geol. 10, 11, 12, as a preparation for Geol. 13, 14, 15 or for M. Geol. 11, 12, 13.

Geol. 17, 18, 19. Azoic or Archæan Geology—Or the Geology of the older Crystalline Rocks.

Preparation required: Geol. 10, 11, 12, 13, 14, 15; Pet. 1, 2, 3, 4, 5, 6, 10, 11, 12, 13, 14, 15.

Taken with Pet. 7, 8, 9, 16, 17, 18.

Fall, Winter, and Spring, or Summer Terms, 2 hours, 2 credits each.

DEAN WADSWORTH

Geol. 17, 18, 19 take up the history of the discussions relating to the Azoic or Archæan or Pre-Cambrian system, and the development of the views relating thereto. It will describe the older crystalline rocks, their mode of formation, the various sub-divisions of the system or systems and the evidences upon which they are based.

The instruction will be given by lectures and by the study and discussion of the literature.

These courses are intended to continue the work taken in Geol. 10, 11, 12, 13, 14, 15, and in Petrography. This covers one branch of that study the same as M. Geol. 11, 12, 13 does of another. All these courses should be taken by any one preparing to become a Mining Geologist or a Geological Engineer, and would be of great value to any student of mining.

Geol. 20, 21, 22. Physiographic Geology.

Preparation required: Geol. 1 or 2 or 3 or 8, and 5 or 9.

Fall, Winter, and Summer Terms, 2 hours, 2 credits each.

MR. EATON

Geol. 23, 24, 25. Physiographic Geology, continued.

Preparation required: Geol. 20, 21, 22.

Fall, Winter, and Summer Terms, 2 hours, 2 credits each.

MR. EATON

Geol. 20 to 25 will treat of the ancient and modern physiography of the earth including the distribution of land and water so far as known.

Geol. 26, 27, 28. Paleozoic Geology.

Preparation required: Geol. 4 or 9, and Geol. 6, 7.

Fall, Winter, and Spring Terms, 2 hours, 2 credits each.

DR. EASTMAN AND MR. JENNINGS.

Geol. 26, 27, 28 are intended to give the student a practical acquaintance with the typical expressions of plant and animal life known from the different horizons of the Paleozoic era. The succession of faunas and floras throughout the Paleozoic era will be treated here more or less fully, with consideration of the prevailing physical conditions as manifested by the character of fossil remains. These courses should be taken in connection with the laboratory study of Paleontology.

Geol. 29, 30, 31. Mesozoic and Cenozoic Geology.

Preparation required: Geol. 26, 27, 28.

Fall, Winter, and Spring Terms, 2 hours, 2 credits each.

DR. EASTMAN AND MR. JENNINGS.

Geol. 29, 30, 31 form a continuation of the preceding courses and will treat of the history of the Mesozoic and Cenozoic eras in a similar manner to that already outlined for Geol. 26, 27, 28. They should be taken in connection with the laboratory study of Paleontology.

Geol. 35, 36, 37. Glacial Geology.

Preparation required: Geol. 1 or 2 or 3 or 8 and Geol. 4 or 9.

Fall, Winter, and Spring, or Summer Terms, 2 hours, 2 credits each.

MR. EATON

Geol. 35, 36, 37 relate to the general phenomena of ancient and modern glaciation, with particular attention given to North America and Europe.

Geol. 38, 39, 40. Prehistoric Man.

Preparation required: Geol. 35, 36, 37.

Fall, Winter, and Summer Terms, 2 hours, 2 credits each.

DEAN WADSWORTH

Geol. 38, 39, 40 treat of the various evidences of the presence of man in the Pleistocene and Recent Periods, as well as the questions relating to his earlier appearance. Attention is further given to the correlated geology.

Geol. 41, 42, 43. Geology of the United States.

Preparation required: Geol. 26, 27, 28, 29, 30, 31.

Fall, Winter, and Spring Terms, 2 hours, 2 credits each.

DR. EASTMAN AND MR. JENNINGS.

In Geol. 41, 42, 43 attention will be given to particular subjects concerning the Paleontology and Geology of the United States.

Geol. 44, 45, 46, 47. Geology of Pennsylvania.

Preparation required: Geol. 1 or 2 or 3 or 8 and Geol. 4 or 9.

Fall, Winter, and Spring, or Summer Terms, 2 hours, 2 credits each.

DR. EASTMAN, AND MESSRS. EATON, LEIGHTON, AND JENNINGS

Attention is given in Geol. 44, 45, 46, 47 to the topography of the State, its various geological formations, their distribution and relation, and to their economic deposits and characteristic fossils.

Geol. 48, 49, 50, 51. Field Geology and Geological Surveying and Mapping.

Preceded by or taken with Geol. 1 or 2 or 3 or 8 and Geol. 4 or 9.

Fall, Winter, Spring, and Summer Terms, 6 hours, 2 credits each.

MESSRS. EATON AND LEIGHTON

Geol. 52, 53, 54, 55. Field Geology and Geological Surveying and Mapping.

Preparation required: Geol. 48, 49, 50, or 51.

Fall, Winter, Spring, and Summer Terms, 6 hours, 2 credits each.

MESSRS. EATON AND LEIGHTON

Geol. 56, 57, 58, 59. Field Geology and Geological Surveying and Mapping.

Preparation required: Geol. 52, 53, 54 or 55.

Fall, Winter, Spring, and Summer Terms, 6 hours, 2 credits each.

MESSRS. EATON AND LEIGHTON

Geol. 60, 61, 62, 63. Field Geology and Geological Surveying and Mapping.

Preparation required: Geol. 56, 57, 58, or 59.

Fall, Winter, Spring, or Summer Terms, 6 hours, 2 credits each.

MESSRS. EATON AND LEIGHTON

In Geol. 48 to 63 the student is taught to make observations, to use the instruments employed in geological surveying, to determine the rocks in the field, their relation, and to make geological maps and sections of the area studied.

The work in Field Geology and in the Geological Laboratory is intended to supplement the work in Geology and Mining. It is **purposed** to train the student in the practical methods of observation in the field and in making his own maps and sections in the laboratory. Excursions will be taken for the purpose of field study, mainly on Saturdays.

Any student selecting these subjects will be expected to put in six hours of service on Saturday as required and unless he is prepared to do so he should not take any of these courses, and cannot be given credit for any of them.

Geol. 64. History of Geology.

Preparation required: Geol. 10, 11, 12, 13, 14, 15.

Fall Term, 2 hours, 2 credits.

This course covers the general history of Geology and Geological Research, and the instruction is given by means of lectures, collateral reading, study of the literature, and quizzes.

Geol. 65, 66. History of Geological Research in the United States.

Preparation required: Geol. 64.

Winter, and Spring, or Summer Terms, 2 hours, 2 credits each.

DEAN WADSWORTH

Geol. 65 and 66 continue and supplement the work in Geol. 64, and is taught in a similar manner. These courses are intended for the advanced students, who propose to devote themselves to research work or teaching, in Geology or Mining Geology.

Geol. 67, 68, 69, 70. Practical Work in Geology.

Preparation required: Geol. 1 or 2 or 3 or 8, and 4 or 9, also Geol. 48, 49, 50.

13 weeks, 18 credits each.

Geol. 71, 72, 73. Geological Education.

Preparation required: Geol. 1 or 2 or 3 or 8 and Geol. 4 or 9 or their equivalents.

Fall, Winter, and Spring, or Summer Terms, 2 hours, 2 credits each.

DEAN WADSWORTH

Geol. 71, 72, 73 are intended to cover the principles and philosophy of Geology and the methods of teaching them. The courses are especially intended for teachers and will be varied according to their needs. The subject will be taught by lectures and by the use of one or more texts to give the needed practical illustrations.

Geol. 74, 75, 76. Geological Literature.

Preparation required: Geol. 3, 4.

Fall, Winter, and Summer Terms, 7 hours, 3 credits each.

MR. EATON

The aim of the course is to familiarize the student with the works of Geology, and the more important papers which have appeared in periodical form. Practice in making abstracts will be afforded. Each man will be expected, as the result of his reading, to write a thesis upon some broad theme, preferably of a philosophic nature. One hour conference and discussion with the instructor per week is required in addition to six hours of reading. The technological room of the Carnegie Library offers exceptional facilities for reference reading and research.

Geol. 77, 78, 79. Physical and Chemical Geology.

Preparation required: Geol. 8 and 9, or their equivalents.

Fall, Winter, and Spring Terms, 3 hours, 3 credits each.

Twice a week 7:30 to 9 P. M.

DEAN WADSWORTH

This work is intended to give advanced instruction in Physical and Chemical Geology. It is given as a continuation of Geol. 8 and 9, for properly prepared students who desire to continue their geological instruction. The work will consist of text-book work, lectures, discussions and quizzes. It will be varied according to the preparation, knowledge, and rapidity of advancement of the class.

GRADUATE WORK

DEAN WADSWORTH, DR. EASTMAN, AND MESSRS. EATON, LEIGHTON, AND JENNINGS

Opportunities will be offered to graduates and other properly qualified students to undertake work in certain advanced lines or study, or in some cases to pursue special topics of original research, such work to be counted toward a master's or doctor's degree if the student so elects. Graduate courses in chemical, physiographic, or biological geology may be taken by students who have had the requisite preparation, the precise nature of such courses being indicated more or less provisionally at the present time, and purposely made elastic to some extent, so as to meet the requirements of the individual student who may be desirous of higher instruction or of improving the facilities that are offered for original research.

It is believed that the facilities which actually exist at the present time, and those which are in anticipation, such for instance as may be provided through utilization of the large resources of the Carnegie Insti-

tute (Library and Museum), in addition to the regular equipment of the University, to say nothing of the field region of Western Pennsylvania and adjacent states,—are of an extremely high order of excellence, and compare favorably with many of our older Universities.

Following is a provisional schedule of courses that may be offered, or of lines of research that may be profitably pursued under the personal guidance of the Dean and members of the teaching staff.

The subjects below can be taken for one, two, three, or four terms, from 3 to 60 hours a week, with from 1 to 20 credits a term. For convenience in Registration each term's work is numbered separately.

Geol. 301, 302, 304. Research Work in Geology.

Preparation required: Geol. 10, 11, 12, 13, 14, 15, 17, 18, 19 or 26, 27, 28, 29, 30, 31.

DEAN WADSWORTH, DR. EASTMAN, AND MESSRS. EATON, LEIGHTON,
AND JENNINGS

Geol. 305, 306, 307, 308. Research Work in Field Geology.

Preparation required: Geol. 5, 48, 49, 50 or 51, 52, 53, 54 or 55.

DR. EASTMAN, AND MESSRS. EATON, LEIGHTON, AND JENNINGS

Geol. 309, 310, 311, 312. Research Work in Physical Geology.

Preparation required: Geol. 10, 11, 12, 13, 14, 15, 17, 18, 19.

DEAN WADSWORTH AND MESSRS. EATON AND LEIGHTON

Geol. 313, 314, 315, 316. Research Work in Chemical Geology.

Preparation required: Ch. 9, 10, 11, 21, 22, 23; Geol. 10, 11, 12, 13, 14, 15.

DEAN WADSWORTH AND MESSRS. EATON AND LEIGHTON

Geol. 317, 318, 319, 320. Research Work upon Volcanoes and Volcanic Action.

Preparation required: Geol. 10, 11, 12, 13, 14, 15, 17, 18.

DEAN WADSWORTH

Geol. 321, 322, 323, 324. Research Work upon Earthquakes and Earthquake Action.

Preparation required: Geol. 10, 11, 12, 16.

DEAN WADSWORTH AND MESSRS. EATON AND LEIGHTON

Geol. 325, 326, 327, 328. Research Work upon the Earth's Origin and Structure.

Preparation required: Geol. 10, 11, 12, 13, 14, 15, 17, 18, 19.

DEAN WADSWORTH

Geol. 329, 330, 331, 332. Research Work in Stratigraphical or Historical Geology.

Preparation required: Geol. 4 or 9, 26, 27, 28, 29, 30, 31.

DR. EASTMAN, AND MESSRS. EATON, LEIGHTON, AND JENNINGS

Geol. 333, 334, 335, 336. Research Work in Azoic or Archæan Geology.

Preparation required: Geol. 10, 11, 12, 13, 14, 15, 17, 18, 19.

DEAN WADSWORTH

Geol. 337, 338, 339, 340. Research Work in Paleozoic Geology.

Preparation required: Geol. 26, 27, 28.

DR. EASTMAN AND MR. JENNINGS

Geol. 341, 342, 343, 344. Research Work in Mesozoic Geology.

Preparation required: Geol. 26, 27, 28, 29, 30, 31.

DR. EASTMAN AND MR. JENNINGS

Geol. 345, 346, 347, 348. Research Work in Cenozoic Geology.

Preparation required: Geol. 26, 27, 28, 29, 30, 31.

DR. EASTMAN AND MR. JENNINGS

Geol. 349, 350, 351, 352. Research Work in Glacial Geology.

Preparation required: Geol. 35, 36, 37.

MR. EATON

Geol. 353, 354, 355, 356. Research Work relating to Prehistoric Man.

Preparation required: Geol. 38, 39, 40.

DEAN WADSWORTH

Geol. 357, 358, 359, 360. Research Work in Physiographic Geology.

Preparation required: Geog. 10, 11, 12 or Geol. 20-25.

DR. ORTMANN AND MR. EATON

Geol. 361, 362, 363, 364. Research Work in the Geology of the United States.

Preparation required: Geol. 41, 42, 43.

DR. EASTMAN AND MR. JENNINGS

Geol. 365, 366, 367, 368. Research Work in the Geology of Pennsylvania.

Preparation required: Geol. 44, 45, 46, 47.

DRS. ORTMANN AND EASTMAN AND MESSRS. EATON, LEIGHTON, AND JENNINGS

Geol. 369, 370, 371, 372. Research Work in the History of Geology.

Preparation required: Geol. 64.

DEAN WADSWORTH

Geol. 373, 374, 375, 376. Research Work upon the Development of Geology and Geological Ideas in the United States.

Preparation required: Geol. 65, 66.

DEAN WADSWORTH

Geol. 377, 378, 379, 380. Research Work upon Geological Education.

Preparation required: Geol. 71, 72, 73.

DEAN WADSWORTH

Geol. 6, 7, 10-47, 64-66, 71-76 are intended for Graduate students as well as for Undergraduates.

See also Graduate Department, Part IX, University catalog.

IV. METALLURGY
UNDERGRADUATE WORK
PROFESSOR GOODALE AND MR. RAY

Met. 1. General Metallurgy.

Preparation required: Ch. 1, 2; Min. 3, 4, 5.

Fall or Summer Term, 3 hours, 3 credits.

PROFESSOR GOODALE OR MR. RAY

This is an elementary subject giving the principles which underlie the general subject of Metallurgy. It deals briefly with fuels, fluxes, slags, furnaces, refractory materials, metallurgical processes, and aims to cover the entire field in preparation for the more detailed courses which are given later, and is required of all candidates for a degree. Candidates for the degree of Metallurgical Engineer or Bachelor of Science or short courses in Metallurgy may substitute Met. 2 for Met. 1; courses Met. 2, 3, and 7 constituting an introductory series for further work in Metallurgy.

Met. 2. Calorimetry, Pyrometry, Fuels, etc.

Preparation required: Ch. 1, 2; Min. 3, 4, 5.

Fall Term, 2 hours, 2 credits.

PROFESSOR GOODALE

Met. 3, 4. Furnaces and Refractory Materials.

Preparation required: Met. 2; Ch. 1, 2.

Winter and Spring Terms, 2 hours, 2 credits each.

PROFESSOR GOODALE

Met. 5. Fuels, Coal, Coke, Gas, etc.

Preparation required: Met. 2.

Winter Term, 2 hours, 2 credits.

PROFESSOR GOODALE

Met. 6. Coke, its Manufacture, Properties, and Uses.

Preparation required: Met. 2 and 5.

Spring Term, 2 hours, 2 credits.

PROFESSOR GOODALE

Courses 2 to 6, inclusive, treat of Heat and Temperature measurements, Fuels and Combustion, Furnaces, their construction and uses. Courses 2 and 3 are introductory and are required for all Metallurgical Engineers. Courses 4, 5, and 6 are more advanced.

Met. 7. Metallography—Alloys.

Preparation required: Met. 2.

Spring or Summer Term, 2 hours, 2 credits.

PROFESSOR GOODALE AND MR. RAY

Met. 8, 9. Metallography.

Preparation required: Met. 7; Min. 3, 4, 5; Ch. 2.

Fall and Winter Terms, 2 hours, 2 credits each.

PROFESSOR GOODALE

Metallography deals with the manufacture, properties, and uses of

alloys, such as brasses, bronzes, fusible metals, solders, friction metals, etc., the theories of heat treatment of metals and alloys, and with the methods of making the structure visible. It also considers the influence of changes of structure on the properties of the metals or alloys.

Met. 10. Metallurgical Calculations, Introductory.

Preparation required: Ch. 1, 2; Met. 2, 3, 7; Ore. 1, 2.

Fall or Summer Term, 3 hours, 3 credits.

PROFESSOR GOODALE AND MR. RAY

Met. 11, 12. Metallurgical Calculations, continued.

Preparation required: Met. 10, 16.

Winter and Spring Terms, 3 hours, 3 credits.

PROFESSOR GOODALE

Met. 13, 14, 15. Metallurgical Calculations, Advanced Work.

Preparation required: Met. 10, 11, 12.

Fall, Winter, and Spring Terms, 2 hours, 2 credits.

PROFESSOR GOODALE

Subjects 10 to 15 deal with the solution of such mathematical problems as the metallurgist will be called upon to solve, involving the application of chemistry, physics, and metallurgical principles.

Met. 16, 17, 18. Metallurgy of Iron.

Preparation required: Met. 2, 3, 7, 10.

Fall, Winter, and Spring Terms, 2 hours, 2 credits.

PROFESSOR GOODALE

Courses 16 to 18 deal with the blast furnace and manufacture of iron, with foundry work and the constitution and properties of iron. Some of the topics considered are as follows: The furnace burden, ore mixing, operation of the blast furnace, chemical reactions of the blast furnace, the use of dry blast, the grading and testing of pig iron, methods of re-melting, making malleable castings, the puddling furnace, etc., etc.

Met. 19, 20, 21. Metallurgy of Steel.

Preparation required: Met. 2, 3, 7, 10, 11, 16, 17.

Fall, Winter, and Spring Terms, 2 hours, 2 credits.

PROFESSOR GOODALE

Met. 22. Metallurgy of Iron and Steel. Short general course.

Preparation required: Ch. 1, 2.

Summer Term, 3 hours, 3 credits.

MR. RAY

Courses 19 to 21 comprise a study of the various steel making processes, including the acid and basic Bessemer and open hearth, and the crucible and electric furnace methods; also the mechanical and heat treatment of steel; alloy steels; the properties and constitution of steel, etc., etc. Met. 22 is intended to be a brief course covering both iron and steel in a more elementary manner.

Met. 23, 24. Metallurgy of Lead.

Preparation required: Met. 2, 3, 10; Ore. 1, 2.

Fall and Winter Terms, 2 hours, 2 credits.

MR. RAY

Courses 23 and 24 cover the preparation and properties of lead, including the roasting of its ores, blast furnace and reverberatory smelting furnace and electrolytic refining, etc.

Met. 25, 26. Metallurgy of Copper.

Preparation required: Met. 2, 3, 7, 10; Ore. 1, 2.

Fall, Winter, or Spring Terms, 2 hours, 2 credits each.

PROFESSOR GOODALE

Courses 25 and 26 cover the production and properties of copper, including the roasting of its ores, blast furnace and reverberatory matte smelting, pyritic smelting, Bessemerizing, and furnace and electrolytic refining.

Met. 27, 28. Metallurgy of Zinc.

Preparation required: Met. 2, 3, 10; Ore. 1, 2.

Fall, Winter, or Summer Terms, 2 hours, 2 credits each.

MR. RAY

Met. 29. Metallurgy of the Minor Metals.

Preparation required: Met. 2, 16 or 23 or 25 or 27.

Winter or Summer Term, 2 hours, 2 credits.

MR. RAY

Met. 30. Metallurgy of the Rare Metals.

Preparation required: Met. 29.

Fall or Summer Term, 2 hours, 2 credits.

MR. RAY

Courses 29 and 30 deal with the production and properties of the less important metals, such as tin, antimony, nickel, chromium, manganese, etc.

Met. 31, 32, 33. Metallurgy of Gold, Silver, and Platinum.

Preparation required: Ore. 1, 2; Met. 2, 23 or 25.

Fall and Winter or Summer Terms, 2 to 4 hours, 2 to 4 credits each.

MR. RAY

Courses 31 to 33 cover briefly the occurrence, association, etc., of ores, preparation of ores, stamp milling, cyaniding, chlorination, copper and lead smelting for gold and silver, refining alloys, working the metals, etc. Course 33 may be arranged to include the work of both 31 and 32 as a 4 hour subject is desired. For detail courses on stamp milling, cyaniding, etc., see Ore Dressing.

Met. 34, 35, 36. Hydro-Metallurgy.

Preparation required: Ore. 1, 2 ;Met. 23, or 25, or 27; Physics, 1, 2, 3, or 11, 12, 13; Ch. 1, 2.

Fall, Winter, and Summer Terms, 2 hours, 2 credits each.

MR. RAY

Courses 34 to 36 treat of the wet processes of extraction. Suitable laboratory courses should be elected concurrently. The work of these courses is largely carried on by reference reading, for which splendid facilities are available at the Carnegie Library near the University.

Met. 37, 38, 39. Electro-Metallurgical Processes.

Preparation required: Met. 2, 3, 7, 10, 11, or 12, 19, or 23, or 25, or 27.

Fall, Winter, and Spring Terms, 2 to 4 hours, 2 to 4 credits each.

PROFESSOR GOODALE

Courses 37 to 39 deal with the electric furnace, and the electro-thermic and electrolytic methods for reduction and refining of the various metals. The courses require a knowledge of electricity and of the general metallurgy of the metals treated.

Met. 40, 41, 42. Metallurgical Designing.

Preparation required: Met. 2, 3, 10; Ore. 1, 2.

Fall, Winter, and Spring or Summer Terms, 3 to 36 hours, 1 to 12 credits each.

PROFESSOR GOODALE AND MR. RAY

Courses 40 to 42 cover the designing of furnaces, smelting plants, ore dressing machinery and plants and other metallurgical and coal washing apparatus, etc. Besides the preparation required as noted above the student must have completed the course regularly given in the metallurgy of the particular metal for whose treatment he is to design apparatus.

Met. 43, 44, 45. Metallurgical Laboratory.

Preparation required: Ch. 1, 2.

Fall, Winter, Spring and Summer Terms, 6 hours, 2 credits each.

PROFESSOR GOODALE AND MR. RAY

Met. 46, 47, 48. Metallurgical Laboratory.

Preparation required: Met. 43, 44, 45.

Fall, Winter, Spring and Summer Terms, 6 hours, 2 credits each.

PROFESSOR GOODALE AND MR. RAY

Met. 49, 50, 51. Metallurgical Laboratory.

Fall, Winter, Spring, and Summer Terms, 6 hours, 2 credits each.

PROFESSOR GOODALE AND MR. RAY

Met. 52, 53, 54. Metallurgical Laboratory.

Taken with Met. 43, 44, 45.

Fall, Winter, Spring, and Summer Terms, 3 to 54 hours, 1 to 18 credits each.

PROFESSOR GOODALE AND MR. RAY

Met. 55, 56, 57. Metallurgical Laboratory.

Taken with Met. 46, 47, 48.

Fall, Winter, Spring, and Summer Terms, 3 to 54 hours, 1 to 18 credits each.

PROFESSOR GOODALE AND MR. RAY

Met. 58, 59, 60. Metallurgical Laboratory.

Taken with Met. 49, 50, 51.

Fall, Winter, Spring, and Summer Terms, 3 to 54 hours, 1 to 18 credits each.

PROFESSOR GOODALE AND MR. RAY

Met. 61, 62, 63. Hydro-Metallurgical Laboratory.

Preparation required: Same as Met. 34, 35, 36.

Taken with Met. 34, 35, 36.

Fall, Winter, and Summer Terms, 6 hours, 2 credits.

MR. RAY

Met. 64, 65, 66. Hydro-Metallurgical Laboratory.

Preparation required: Met. 61, 62, 63.

Fall, Winter, and Summer Terms, 3 to 36 hours, 1 to 12 credits.

MR. RAY

Met. 67, 68, 69. Electro-Metallurgical Laboratory.

Preparation required: Same as Met. 37, 38, 39.

Taken with Met. 37, 38, 39.

Fall, Winter, and Spring Terms, 6 hours, 2 credits each.

PROFESSOR GOODALE

Met. 70, 71, 72. Electro-Metallurgical Laboratory.

Preparation required: Met. 67, 68, and 69.

Fall, Winter, and Spring Terms, 3 to 36 hours, 1 to 12 credits each.

PROFESSOR GOODALE

The courses in Metallurgical Laboratory work are intended to give the student thorough practice in the various testing operations required in practical metallurgy, as well as a more thorough knowledge of the principles involved in theoretical metallurgy.

Met. 73, 74, 75. Fire Assaying.

Preparation required: Met. 1 or 2; Min. 3, 4, 5.

Fall, Winter, Spring, and Summer Terms, 7 hours, 3 credits each.

One hour lecture and six hours laboratory.

PROFESSOR GOODALE AND MR. RAY

Met. 76, 77, 78. Fire Assaying.

Preparation required: Met. 73, 74, 75.

Fall, Winter, Spring, and Summer Terms, 3 to 36 hours, 1 to 12 credits each.

PROFESSOR GOODALE AND MR. RAY

Met. 79, 80, 81. Wet Assaying.

Preparation required: Ch. 9, 10, 11.

Fall, Winter, Spring, and Summer Terms, 6 hours, 2 credits each.

PROFESSOR GOODALE AND MR. RAY

Met. 82, 83, 84. Wet Assaying.

Preparation required: Met. 79, 80, 81.

Fall, Winter, Spring, and Summer Terms, 3 to 36 hours, 1 to 12 credits

PROFESSOR GOODALE AND MR. RAY

The courses in Assaying are intended to give the student a thorough knowledge of practice in the methods of chemical control of metallurgical operations, both by fire and wet methods. Large opportunity is also given for extended work on special problems as may be desired.

Met. 85, 86, 87, 88. Practical Work in Metallurgy.

Preparation required: Ch. 1, 2; Min. 3, 4, 5.

13 weeks, 18 credits each.

Met. 89, 90, 91, 92. Practical Work in Assaying.

Preparation required: Ch. 1, 2; Min. 3, 4, 5.

13 weeks, 18 credits each.

Met. 93, 94, 95, 96. Practical Work in Hydro-Metallurgy.

Preparation required: Ch. 1, 2; Min. 3, 4, 5.

13 weeks, 18 credits each.

Met. 97, 98, 99, 100. Practical Work in Electro-Metallurgy.

Preparation required: Ch. 1, 2; Min. 3, 4, 5.

13 weeks, 18 credits each.

Courses 85 to 100 give the student an opportunity to work in various metallurgical plants as a part of the preparation for his degree. A thesis covering the work accomplished is required on the completion of each period of consecutive similar work. The work may be done any time during the student's course, but arrangement must be made with the head of the department and Dean prior to the undertaking of the course to be sure that the work undertaken will be of satisfactory character to apply on these courses.

Met. 101, 102, 103. Reference Work on Current Literature.

Preparation required: Met. 1 or 2, 16 or 23 or 25 or 27; Ore. 1, 2.

Fall, Winter, Spring, and Summer Terms, 6 to 12 hours, 2 to 4 credits each.

PROFESSOR GOODALE AND MR. RAY

Courses 101 to 103 are limited to give the student practice in hunting up current data on metallurgical problems; abstracts of articles are to be reported at class meetings, as well as more extended theses, the result of study on one problem for several weeks, etc., etc. The ability to pick out the important data from current literature is of great importance to the engineer, and these courses are to start the student along the right lines in doing this.

Met. 104, 105, 106. Metallurgical Excursions.

Preparation required: Met. 1 or 2, 3 and 7.

Fall, Winter, Spring, and Summer Terms, 6 to 12 hours, 2 to 4 credits.

PROFESSOR GOODALE AND MR. RAY

These courses include visits of inspection to the numerous metallurgical plants in the vicinity of Pittsburgh, together with reports on the same. Two class meetings per week are scheduled for lectures, discussions, etc.

Met. 107, 108, 109. General Introduction to Metallurgy.

Fall, Winter, and Spring Terms, 3 hours, 3 credits each, 7:30 to 9 P. M.

PROFESSOR GOODALE

These courses take up the general study of metals and alloys, high temperature measurements, general metallurgical operations, slags and mattes and other products, furnaces, fuels, calorimetry, etc., including the application of elementary physics, and chemistry to metallurgical work. A knowledge of chemistry and physics is most desirable in preparation for this course. No set preparation is, however, demanded, except in such cases where the student is pursuing the course to secure "College credit" when the same preparation as for Met. 1 is demanded. Text-book: Fulton's *Principles of Metallurgy*.

Met. 110, 111, 112. Metallurgy of Iron and Steel.

Preparation required: Met. 107, 108, 109, or equivalent.

Fall, Winter, and Spring Terms, 3 hours, 3 credits each, 7:30 to 9 P. M.

PROFESSOR GOODALE

These courses take up the study of Iron and Steel, including a study of the blast furnace, the various steel making processes, as Bessemer, open hearth, crucible, the mechanical and heat treatment of steel, steel and iron foundry work, etc. Text-book for 1910-1911, Stoughton's *The Metallurgy of Iron and Steel*.

Met. 113, 114, 115. General Metallurgy.

Preparation required: Met. 107, 108, 109, or equivalent.

Fall, Winter, and Summer Terms, 3 hours, 3 credits each, 7:30 to 9 P. M.

MR. RAY

These courses take up a brief study of the metallurgy of the important common metals, including iron and steel, (briefly), copper, lead, gold, silver, and platinum, zinc, tin, mercury, nickel, etc. The smelting and milling processes, refining, and the properties and working of the metals are taken up in greater or less detail according to the importance of each. Lectures, text-books, and reference reading.

Met. 116. Fire Assaying.

Fall Term, 6 hours, 2 credits, 7:30 to 10:30 P. M.

MR. RAY

This is almost entirely a laboratory course, and takes up the deter-

mination of lead, silver, gold, and platinum in ores, and metallurgical products. Each student makes 50 assays under the direction of the instructor, regulates the furnace himself, and carries on all the operations usual in any assay office for this work. Text-book, Fulton's *Manual of Assaying*.

Met. 117. Wet Assaying.

Winter Term, 6 hours, 2 credits, 7:30 to 10:30 P. M.

Mr. RAY

This course takes up the chemical work of an iron and steel works laboratory. Each student makes 50 determinations as the regular work of the course. A knowledge of chemistry is essential for this course, and some knowledge of qualitative and quantitative analysis is most desirable.

Met. 118, 119. Metallurgical Laboratory Experiments.

PROFESSOR GOODALE

In this course a number of experiments of a metallurgical nature are made and the students in addition to carrying on the actual experiments make all the physical and chemical determinations for the control of same and study of the results. A knowledge of chemistry is required, and a knowledge of qualitative and quantitative analysis most desirable. Reference text-book: Howe's *Metallurgical Laboratory Notes*.

Because of the nature of the work and expense of the courses, they can only be actually given when a class of suitable size presents itself.

GRADUATE WORK

PROFESSOR GOODALE AND MR. RAY

The subjects given below can be taken for one, two, three, or four terms, from 3 to 60 hours a week, and with from 1 to 20 credits a term. Each term's work is given a distinct number for convenience in registration.

Met. 301, 302, 303, 304. Assaying Laboratory.

Preparation required: Met. 73, 74, 75, 79, 80, 81.

Met. 305, 306, 307, 308. Research Work in Metallurgy.

Preparation required: Met. 19, 20, or 23, 24 or 25, 26, 43, 44, 45, 73, 79, 80, 81.

Met. 309, 310, 311, 312. Research Work in Assaying.

Preparation required: Met. 73, 74, 75, 79, 80, 81.

Met. 313, 314, 315, 316. Research Work in Hydro-Metallurgy.

Preparation required: Met. 34, 35, 36, 43, 44, 45, 52, 53, 54, 73, 74, 79, 80, 81.

Met. 317, 318, 319, 320. Research Work in Electro-Metallurgy.

Preparation required: Met. 37, 38, 39, 43, 44, 45, 58, 59, 60, 73, 79, 80.

Met. 321, 322, 323, 324. Research Work in Ferrous Metallurgy.

Preparation required: Met. 16, 17, 18, 19, 20, 21, 43, 44, 45, 79, 80, 81.

Met. 325, 326, 327, 328. Research Work in Non-ferrous Metallurgy.

Preparation required: Met. 23, 24, or 25, 26, or 31, 32, 43, 44, 45, 73, 74, 79, 80, 81.

Met. 329, 330, 331, 332. Research Work upon Coke and Coke Making.

Preparation required: Met. 5, 6, 43; Ore. 7, 8, 9; Ch. 9, 10, 11.

Met. 333, 334, 335, 336. Research Work in Metallography.

Preparation required: Met. 19, 20, 21 or 25, 26.

Met. 337, 338, 339, 340. Research Work upon the History of Metallurgy.

Preparation required: Met. 19, 20, 21 or 25, 26.

Met. 341, 342, 343, 344. Research Work upon Metallurgical Education.

Preparation required: Met. 19, 20, 23, 24, 25, 26, 31, 32; Psy. 1, 2, 3; Soc. 4; Ed. 1, 2, 4, 9.

Met. 16-72, 76-84, 101-106 are intended for Graduate as well as Undergraduate students.

See Part IX University Catalog.

V. CRYSTALLOGRAPHY, MINERALOGY, AND LITHOLOGY. UNDERGRADUATE WORK

DEAN WADSWORTH AND MESSRS. LEIGHTON AND EATON

Under Mineralogy it is intended to take up the general principles of Crystallography, Mineralogy, and Lithology or Macroscopical Petrography, with the corresponding laboratory work.

Min. 1. Crystallography and Mineralogy.

Preparation required: Ch. 1, 2, 8; Phy. 11, 12, or 1, 2.

Taken with Phy. 13 or 3.

Summer Term, 8 hours, 4 credits.

MESSRS. LEIGHTON AND EATON

This course is intended primarily for the students of the School of Engineering and the School of Liberal Arts. The work covers two hours of lecture and quiz and six hours of laboratory work. The course will comprise about 127 of the commoner minerals and the principal rocks, such as every engineer and college student should know.

Min. 2. Crystallography and Mineralogy.

Preparation required: Ch. 1, 2 or taken with Ch. 1, 2.

Fall, or Winter, or Spring Term, 8 hours, 4 credits.

MESSRS. LEIGHTON AND EATON

This course is intended for those students of the various schools in the University except Mines who are unable to take Min. 1 on account of not attending during the Summer Term.

Min. 3, 4, 5. Crystallography, Mineralogy, and Lithology.

Fall, Winter, and Spring, or Summer Terms, 14 hours, 6 credits each.

MESSRS. LEIGHTON AND EATON

The work in Min. 3, 4, and 5 is intended for the students of the School of Mines who are candidates for a degree, and for those others who may desire to obtain a practical knowledge of the subject for use in the field and laboratory.

The instruction in Mineralogy is divided into five parts: Crystallography, Determinative Mineralogy, Physical Mineralogy, Chemical Mineralogy, and Macroscopical Petrography, or Lithology. These are all taken as consecutive and closely co-ordinated subjects that are essential to a proper comprehension of the subjects of geology and mining.

CRYSTALLOGRAPHY.—The instruction given is by means of a text-book on *Crystallography*, Wadsworth, with lectures and laboratory practice in determining the crystal forms of models and natural crystals.

As the student's future work in Mineralogy depends largely upon his knowledge of Crystallography, he is required to familiarize himself with the principles which it involves, and to become sufficiently expert in determining forms to be able to apply it practically in the Determinative Mineralogy.

This work is supplemented by Mathematical Crystallography, with the use of the goniometer and practice in the drawing of crystals.

DETERMINATIVE MINERALOGY.—For Determinative Mineralogy there is provided a typical set of important minerals, special attention being paid to those of economic value, as well as to those occurring as gangue or rock-forming minerals. Special collections are arranged, showing the physical characters of minerals.

Besides the typical lecture collections of minerals, there are placed in other drawers specimens of the same mineral species. They are arranged in convenient groups, but are unlabeled. These specimens are selected so as to represent as great a variety of forms, appearance, and locality as possible, in order that the student may be made familiar with all the types that he will be likely to meet in his professional practice. Drawers containing the unlabeled minerals are assigned to each student, who is to determine them and recite upon them, not in a class, but singly with the instructor. He is required to do that which the practical mineralogist does: to determine his minerals by the shortest methods possible consistent with accuracy; the method to vary according to the specimen. To this end every method of determination short of quantitative analysis is employed; that is, in each case the crystal form and other physical characters are used, as well as the blowpipe and wet tests, so far as they may be needed.

After the student has studied and recited upon the specimens contained in a sufficient number of drawers of one group, he is assigned drawers containing the unlabeled minerals of another group, which have mixed with them specimens of the preceding group or groups. In this way each student is required to determine in his course from one thou-

sand to three thousand different mineral specimens belonging to the selected species.

As a basis for the Determinative Mineralogy, Dr. Edward S. Dana's *Text-Book of Mineralogy* is used, supplemented by *Practical Mineralogy*.^{*} Wadsworth. In the latter the characteristic features of each mineral, its uses, and the practical methods employed to distinguish each one are pointed out. Especial attention is given to the methods needed in the field and mine, where one cannot have recourse to a chemical laboratory. Every effort is made to train the student to close, accurate observation, to reason correctly upon what he sees, and to exercise good judgment in his decision.

The result of this work is such that a student not only knows how to proceed in order to determine any mineral that he may meet, but he is also enabled to recognize at sight, or by simple tests, the great majority of specimens belonging to the important mineral species selected.

In the Determinative Mineralogy two students' collections are used—one covering about 127 species and their varieties of the important rock-forming and economic minerals, together with the more common rocks, which is used for the elementary work. The second collection contains all the important minerals that are sufficiently abundant to be available for general student work—some 300 species.

PHYSICAL MINERALOGY.—In this subject are taken up the general physical properties of minerals; and the study of their alterations; the use of the polariscope, etc.

CHEMICAL MINERALOGY.—Under this heading are considered the method of analyzing minerals and rocks; their chemical constitution; their chemical classification; etc.

LITHOLOGY OR MACROSCOPICAL PETROGRAPHY.—In this subject the student is taught to determine by means of the eye, the lens, and a few simple tests how to recognize the principal rocks of the globe. For this work collections of rock specimens are arranged for the use of the student. The course of instruction is similar to that followed in the course of Mineralogy. Lectures are given upon the specimens of the typical collections, the method of classification is explained, and the distinguishing characters of the different groups, species, and varieties are pointed out. Particular attention is called to the variations and alterations in rocks and to their local modifications due to their special mode of occurrence in the field.

The object of the course is to give the student such training in the practical determination of rocks as will enable him to know them in the field and mine, as well as to observe their alterations and modifications—subjects that have very important bearings upon the vital questions relating to ore deposits.

^{*}The first edition of this work has been exhausted but the second edition is being prepared, meanwhile the instruction is given by lecture notes covering the same ground.

After the study of a sufficiently large number of types has been made the student has assigned to him a large number of drawers containing unlabeled specimens of these rocks, which he is expected to determine and recite upon, as he has done in his study of minerals. The course is thus made thorough and practical, and is adapted to the needs of the miner, the teacher, and the geologist, giving them a training which they can make use of in their future work.

Min. 6, 7, 8. Mineralogy and Lithology.

Preparation required: Min. 3, 4, 5.

Fall, Winter, Spring, or Summer Terms, 6 hours, 2 credits each.

MR. LEIGHTON OR MR. EATON

Min. 9, 10, 11. Mineralogy and Lithology.

Preparation required: Min. 6, 7, 8.

Fall, Winter, Spring, or Summer Terms, 6 hours, 2 credits each.

MR. LEIGHTON OR MR. EATON

Min. 12, 13, 14. Mineralogy and Lithology.

Preparation required: Min. 9, 10, 11.

Fall, Winter, Spring, or Summer Terms, 6 hours, 2 credits each.

MR. LEIGHTON OR MR. EATON

Min. 15, 16, 17. Mineralogy and Lithology.

Taken with Min. 3, 4, 5.

Fall, Winter, Spring, or Summer Terms, 3 to 45 hours, 1 to 15 credits each.

MR. LEIGHTON OR MR. EATON

Min. 18, 19, 20. Mineralogy and Lithology.

Preparation required: Min. 3, 4, 5.

Fall, Winter, Spring, or Summer Terms, 3 to 45 hours, 1 to 15 credits each.

MR. LEIGHTON OR MR. EATON

Min. 21, 22, 23. Mineralogy and Lithology.

Preparation required: Min. 18, 19, 20.

Fall, Winter, Spring, or Summer Terms, 3 to 45 hours, 1 to 15 credits each.

MR. LEIGHTON OR MR. EATON

Min. 24, 25, 26. Mineralogy and Lithology.

Preparation required: Min. 21, 22, 23.

Fall, Winter, Spring, or Summer Terms, 3 to 45 hours, 1 to 15 credits each.

MR. LEIGHTON OR MR. EATON

Min. 27, 28, 29. Blowpipe Analysis.

Preceded by or taken with Ch. 1, 2, 8; Min. 3, 4, 5.

Fall, Winter, and Spring, or Summer Terms, 3 to 18 hours, 1 to 6 credits each.

MR. LEIGHTON OR MR. EATON

Min. 30, 31, 32. Mathematical Crystallography.

Preparation required: Mat. 5, 6; Min. 3, 4, 5.

Fall, Winter, and Spring, or Summer Term, 6 to 60 hours, 2 to 20 credits each.

MR. EATON

In Min. 30, 31, 32 is taken up the applications of **Mathematics in calculating** the axial ratios, and the other constants in crystals, also the methods of projecting and drawing crystals. It is proposed in these subjects to give a full and complete course in **Mathematical Crystallography** and crystal projection. The associated practice is **taken in the Crystallographic Laboratory.**

Min. 33, 34, 35. Physical Mineralogy.

Preparation required: Min. 3, 4, 5, 30, 31, 32; Phy. 1, 2, 3, or 11, 12, 13; Pet. 1, 2, 3, 10, 11, 12.

Fall, Winter, Spring, or Summer Terms, 6 to 60 hours, 2 to 20 credits each.

DEAN WADSWORTH AND MR. EATON

Min. 36, 37, 38. Physical Mineralogy, continued.

Preparation required: Min. 33, 34, 35.

Fall, Winter, Spring, or Summer Terms, 6 to 60 hours, 2 to 20 credits each.

DEAN WADSWORTH AND MR. EATON

Subjects Min. 33 to 38 are arranged for the purpose of imparting to the student a good knowledge of the various physical properties of minerals, including their optical characteristics and their alterations.

Min. 39, 40, 41. Chemical Mineralogy.

Preparation required: Ch. 1, 2, 8, 9, 10, 11; Min. 30, 31, 32.

Fall, Winter, Spring, or Summer Terms, 6 to 60 hours, 2 to 20 credits each.

DEAN WADSWORTH AND MESSRS. EATON AND LEIGHTON

Min. 42, 43, 44. Chemical Mineralogy.

Preparation required: Min. 39, 40, 41.

Fall, Winter, Spring, or Summer Terms, 6 to 60 hours, 2 to 20 credits each.

DEAN WADSWORTH AND MESSRS. EATON AND LEIGHTON

In Min. 39 to 44 is taken up the chemical properties of Minerals, their analysis and the various analytical methods, the calculation of formulas, etc. This work should be taken in connection with Min. 33-38 and Ch. 12, 13, 14.

Min. 45, 46, 47, 48. Practical Work in Mineralogy.

Preparation required: Min. 3, 4, 5.

13 weeks, 18 credits each.

Min. 49, 50, 51, 52. Crystallography, Mineralogy, and Lithology.

Fall, Winter, Spring, and Summer Terms, 3 hours, 1 credit. Saturday, 1:30 to 4:30 P. M.

MESSRS. LEIGHTON AND EATON

GRADUATE WORK

DEAN WADSWORTH AND MESSRS. LEIGHTON AND EATON

Each subject is given during the four terms of the year occupying from 6 to 60 hours a week and giving 2 to 20 credits during each term.

Min. 301, 302, 303, 304. Research Work in Crystallography.

Preparation required: Min. 30, 31, 32.

Min. 305, 306, 307, 308. Research Work in Mineralogy.

Preparation required: Min. 3, 4, 5, 6, 7, 8.

Min. 309, 310, 311, 312. Research Work in Physical Mineralogy.

Preparation required: Min. 33, 34, 35, 36, 37, 38.

Min. 313, 314, 315, 316. Research Work in Chemical Mineralogy. .

Preparation required: Min. 39, 40, 41, 42, 43, 44.

Min. 317, 318, 319, 320. Research Work in Determinative Mineralogy.

Preparation required: Min. 3, 4, 5, 6, 7, 8.

Min. 321, 322, 323, 324. Research Work in the Mineralogy of the United States.

Preparation required: Min. 30 to 44.

Min. 325, 326, 327, 328. Research Work in the Mineralogy of Pennsylvania.

Preparation required: Min. 30 to 44.

Min. 329, 330, 331, 332. Research Work upon the History of Crystallography.

Preparation required: Min. 30, 31, 32.

Min. 333, 334, 335, 336. Research Work upon the History of Mineralogy.

Preparation required: Min. 30 to 44.

Min. 337, 338, 339, 340. Research Work in Mineralogical Education.

Preparation required: Min. 30 to 44.

Min. 30-44 are intended for Graduates as well as Undergraduates.

For details see University Catalog Part IX.

VI. MINING (COAL AND METAL MINING, QUARRYING)

UNDERGRADUATE WORK

ASSISTANT PROFESSOR MELLER AND MR. HALDEMAN

The aim of the student in Mining Engineering is to acquire such knowledge as will enable him to successfully carry through a mining enterprise. In order to intelligently conduct mining operations, he will be called upon as an engineer to employ the principles of mathematics, physics, and mechanics; the sciences of geology, mineralogy, chemistry and metallurgy; and the arts of civil, mechanical, and electrical engineer-

ing; he must also have capacity for organization and business management.

The principles, sciences, and arts mentioned are taught by specialists in the different departments; their particular application to Mining is taught under that head.

There are three main lines of election offered to the student:

The Mining of Coal,
The Mining of Metals and Stone,
The Mining of Mineral Fluids and Hydrocarbons.

All students are required to take the course Mine 1, covering the general principles of mining. Following this may be elected courses pertaining to the mining of coal, or metals and stone, or the recovery of the mineral fluids and hydrocarbons, according to the line to which the student wishes to devote most of his time in this department.

Besides the courses under the three heads mentioned, are courses relating to business methods and the economics of mining, which deal with the problems confronting the mine manager, operator, and financial agent. A knowledge of these subjects has usually been gained by experience alone in the active mining field; but a number of carefully selected courses of this character are included in the curriculum of the School.

In connection with the department is a laboratory, equipped with the most modern machinery used in underground work, steam, air, and electricity being directly available as power.

Class instruction is supplemented, where possible, by visits to mines in the vicinity; by reference to models, drawings, and descriptions of plants, etc.

Following is a list of the undergraduate courses offered by the department, with the number of hours recitation and laboratory work in each, and the credits allowed for each. Any of the courses listed will be given in terms other than those shown, provided they are elected by not less than five students. No student will be admitted to any course unless he has the requisite preparation.

Mine. 1. Elements of Mining.

Fall or Summer Term, 3 hours, 3 credits.

ASSISTANT PROFESSOR MELLER AND MR. HALDEMAN

This course is intended to give a resumé of the principles of mining and is required of all candidates for a degree. It is also to serve as a basis for subsequent study in the department. The course includes instruction in:

1. Modes of occurrence of minerals; as beds or seams, veins, and masses.
2. Prospecting: aids, methods, outfit, etc.
3. Boring: purposes and methods of.
4. Breaking ground: by hand tools, by machine; blasting.

5. Support: rock pillars, timber, masonry, brickwork, metallic supports.

6. Exploitation: open, subaqueous, and underground workings, etc.

7. Haulage: methods not involving the use of rails; railways; aerial ropeways.

8. Hoisting: motors, drums, pulley frames; ropes and rope attachments; receptacles, as buckets, cages, skips, safety appliances, etc.

9. Drainage: surface and mine..

10. Ventilation: pure air, constitution and requirements; mine air pollution; natural and artificial ventilation; testing mine air; accidents from mine gases, and their prevention; rescue and resuscitation; etc.

11. Lighting: candles, torches, lamps.

Excursions are made on Saturdays into mines in the vicinity to familiarize the students with the practical application of the principles discussed in the class-room.

Mine. 2, 3. Coal Mining Methods.

Preparation required: Mine. 1; Min. 1, 2; M. Geol. 1.

Winter and Spring or Summer Terms, 2 hours, 2 credits each.

MR. HALDEMAN

Mine. 2 includes the study of the underlying principles of mining anthracite and bituminous coals, as practiced in this state and elsewhere. Owing to the location of the School, the student is afforded exceptional opportunities to learn the actual practice in bituminous mines. Visits for this purpose are made from time to time.

Mine. 3 is a continuation of Mine. 2. It takes up in greater detail the various methods of extracting coal by open cut and underground methods as used in horizontal and slightly pitching seams.

Mine. 4, 5, 6. Coal Mining Machinery.

Preparation required: Mine. 3; Phy. 1, 2, 3, or 11, 12, 13; E. E. 2.

Winter, Spring, and Summer Terms, 5 hours, 3 credits each.

MR. HALDEMAN

Mine. 4 to 6 teach the principles of design and the use of the various types of machines employed in coal mining. The laboratory is equipped with a number of the most modern types of coal mining machines, which are made use of in connection with these courses, the student learning to take down, reassemble, and use each type.

Mine. 7. Mine Gases.

Preparation required: Ch. 1, 2; Phy. 1, 2, 3, or 11, 12, 13; Mine. 2 or 11.

Fall Term, 2 hours, 2 credits.

MR. HALDEMAN

Mine 7 treats of the properties, occurrence, and detection of the gases found in mines.

Mine. 8. Mine Gases.

Preparation required: Mine 7.

Winter Term, 7 hours, 3 credits.

MR. HALDEMAN

Mine 8 is concerned principally with Mine Gas analysis.

Mine. 9. Ventilation, Lighting, etc.

Preparation required: Mine. 8.

First Half Spring Term, 4 hours, 2 credits or Summer Term, 2 hours, 2 credits.

MR. HALDEMAN

Mine. 10. Design of Ventilating Machinery.

Preparation required: Mine. 9; Mec. 2, 5.

Second Half Spring Term, 14 hours, 3 credits, or Summer Term, 7 hours, 3 credits.

MR. HALDEMAN

In courses 9 and 10 especial attention is paid to problems associated with the underground workings of mines; the best methods of ventilating and lighting them; the care of mine gases; the design of the plant necessary to furnish proper ventilation. This work is especially intended to cover the duties of fire bosses and foremen, and to give the knowledge that every superintendent and manager should have.

Mine. 11. Ore Mining Methods.

Preparation required: Geol. 3 and 4 or 5; Min. 3, 4, 5; Mine. 1; M. Geol. 1.

Spring or Summer Term, 3 hours, 3 credits.

ASSISTANT PROFESSOR MELLER

It comprises: Methods of support in extraction of ore, methods of stoping and mining in narrow and wide veins and bedded and massive deposits, including stull and square-set mining, filling and caving methods, and open-cut work.

Mine. 12. Mining for Petroleum, Natural Gas, Asphaltum, and other Hydrocarbons.

Preparation required: Mine. 1; M. Geol. 1.

Winter Term, 2 hours, 2 credits.

ASSISTANT PROFESSOR MELLER

Mine 12 comprises a study of the various methods of winning these materials. Visits of inspection are made to neighboring oil and gas wells.

Mine. 13. Prospecting and Boring.

Preparation required: Mine. 1; M. Geol. 1.

Winter Term, 2 hours, 2 credits.

ASSISTANT PROFESSOR MELLER

Qualifications for and methods of prospecting; purposes of bore holes; methods of boring (a) by rotation, with diamond drills and steel

toothed drills, (b) by percussion, with rods and ropes; survey of bore-holes.

Mine. 14. Shaft Sinking.

Preparation required: Mine. 1.

Winter Term, 2 hours, 2 credits.

MR. HALDEMAN

Vertical, inclined, and combined shafts; location and number of shafts; shape and size; methods of sinking through hard and soft rocks and water-bearing formations; speed of sinking, etc.

Mine. 15. Rock Drills—Design, Construction, and Use.

Preparation required: Mine. 11.

First Half Spring Term, 4 hours, 2 credits.

ASSISTANT PROFESSOR MELLER

A study of the design, construction, and use of standard piston drills, hammer drills, electric drills, with examples of rock drill practice in America, Africa, and Australia.

Mine. 16. Supporting Excavations.

Preparation required: Mine. 11.

Spring Term, 2 hours, 2 credits.

ASSISTANT PROFESSOR MELLER

In Mine. 16 the various methods of supporting excavations are considered—timbering; filling with waste; filling with broken ore; pillars of ore; artificial pillars; caving system, etc.

Mine. 17. Mine Engines and Boilers.

Preparation required: Mine. 1.

Spring Term, 5 hours, 2 credits.

MR. HALDEMAN

A non-mathematical treatment of the steam engine, boiler, and details.

Mine. 18. Power Generation and Transmission.

Preparation required: Mine 17.

Fall Term, 2 hours, 2 credits.

MR. HALDEMAN

Mine. 18 treats of the generation of power at the surface and its transmission to all parts of the mine where it is to be used; also makes a comparative study of steam, compressed air, and electricity as power.

Mine. 19. Compressed Air in Mining.

Preparation required: Mine. 3 or 11, 17; Mec. 5.

Winter Term, 3 hours, 3 credits.

ASSISTANT PROFESSOR MELLER

A study of air compression, expansion, flow of air through pipes, the various types of air compressors and of machines using compressed air as power.

Mine. 20. Electricity applied to Mining.

Preparation required: Mine 3 or 11, 17; E. E. 2.

First Half Spring Term, 10 hours, 3 credits.

MR. HALDEMAN

Dynamo and motor construction, transformers, etc., their selection, installation, and care. The laboratory work has for its object the familiarizing of the student with the construction, care and use of the common forms of electric apparatus used in and about a mine.

Mine. 21. Haulage.

Preparation required: Mine. 3 or 11, 17.

Fall Term, 2 hours, 2 credits.

MR. HALDEMAN

Mine. 21 treats of the different types of haulage used on surface and underground and the conditions favoring each.

Mine. 22. Hoisting and Hoisting Appliances.

Preparation required: Mine. 3 or 11, 17.

Fall Term, 2 hours, 2 credits.

ASSISTANT PROFESSOR MELLER

Treats of the methods of hoisting; hoisting appliances; haulage equipment in shafts, etc.

Mine. 23. Mine Drainage.

Preparation required: Mine. 3 or 11; Mec. 5.

Winter Term, 2 hours, 2 credits.

ASSISTANT PROFESSOR MELLER

Drainage: controlling factors: volume and head of water; systems of drainage; comparative value of various systems, etc.

Mine. 24. Pumps and Pumping Machinery.

Preparation required: Mine. 17.

Winter Term, 2 hours, 2 credits.

ASSISTANT PROFESSOR MELLER

Steam pumps, compressed air pumps; electrical pumps; rod driven pumps; bailing; their application and comparative value.

Mine. 25. Mine Explosives—Their Care and Use.

Preparation required: Mine. 8, and 3 or 11.

First Half Spring Term, 4 hours, 2 credits, or Summer Term, 2 hours, 2 credits.

MR. HALDEMAN

A study of blasting materials, the qualities of explosives, their choice and handling, the preparation of blasts, determination of the charge, charging, firing, etc.

Mine. 26, 27, 28. First Aid to the Injured and Minor Rescue Work.

Preparation required: Mine. 1.

Spring Term, 1 to 3 credits; Summer Term, 2 credits.

DR. WALLGREN

The accidents commonly occurring in mines often prove serious and even fatal by reason of inexperienced handling before the services of a surgeon can be had. These courses are designed to train the student in "First Aids" and includes instruction in the following subjects: Anatomy and Physiology, Bruises, Sprains, Fractures, Wounds, and Hemorrhage; Dressing of Wounds, Bandaging, Shock, of all kinds, Resuscitation, the Administration of Simple Remedies as the case might require, Burns, and Gas Poisoning; Handling and Carrying of the Injured, Modified Stretcher Drill, Emergencies of various kinds, Sanitation, etc.

Certificates of competency will be issued to each student by the American Red Cross Society upon the completion of this course.

Mine. 29 and 30, 31. Mine Rescue Training.

Spring and Summer Terms, 6 hours, 2 credits each.

ASSISTANT PROFESSOR MELLER AND MR. HALDEMAN

Recent explosions and extensive mine fires have brought before the mining industry of the United States the importance of some device whereby underground workings may be explored and rescue work may be carried on even though the mine is filled with irrespirable gases. In the courses here mentioned instruction will be given in the Principles, Design, and Use of the Helmet and Mouth Breathing Devices, Resuscitation Apparatus, and in the Methods of Mine Rescue Work. A thorough training will be given in the use of the above apparatus under conditions similar to those in a mine. Through the courtesy of the United States Bureau of Mines practice work will be done at the Government Station in Pittsburgh under its supervision, and will include the following: Practice in Smoke Chamber, Carrying and Placing Props, Erecting Brattice, Building Brick Stoppings, Carrying Injured Man on Stretcher, Passage Through Exploded Mine, General Mine Work, etc.

Mine. 32. Mine Calculations.

Preparation required: Mine. 1.

Winter Term, 3 hours, 3 credits.

ASSISTANT PROFESSOR MELLER

This course is intended to familiarize the student with the use of the various standard hand-books, by giving him practical problems in connection with the design or working of a plant, and requiring him to use the hand-books in their solution.

Mine. 33. Deep Mining.

Preparation required: Mine 8, 9, and 13 to 25.

Winter Term, 2 hours, 2 credits.

ASSISTANT PROFESSOR MELLER

This course is devoted to a study of the difficulties which may be

expected to be encountered when ore-bodies are mined to depths greater than those of the present day.

Mine. 34. Placer and Hydraulic Mining and Dredging.

Preparation required: Mine. 1; Mec. 5; M. Geol. 1.

Winter Term, 2 hours, 2 credits.

ASSISTANT PROFESSOR MELLER

A study of the occurrence of auriferous gravel deposits, methods of prospecting, development, and working. Detail of ground sluicing, river mining, drift mining, hydraulicking, and dredging.

Mine. 35, 36. Layout of Surface and Underground Plants.

Fall and Winter Terms, 6 hours, 2 credits each.

ASSISTANT PROFESSOR MELLER AND MR. HALDEMAN

The general arrangement of the surface plant in detail, piping in shafts, underground pumps, etc.

Mine. 37, 38, 39. Exploitation and Development of Coal Properties.

Preparation required: Mine. 3.

Fall, Winter, and Summer Terms, 7 hours, 3 credits each.

MR. HALDEMAN

These courses treat of the methods employed in developing a coal property from the time of the sinking of the preliminary bore-holes to the delivery of the coal at the surface.

Mine. 40, 41. Exploitation and Development of Metal Mines.

Preparation required: Mine. 11.

Fall and Winter Terms, 7 hours, 3 credits each.

ASSISTANT PROFESSOR MELLER

Mine. 40 and 41 treat of the exploitation and development of metal properties from the prospect shaft to the delivery of the ore to the mill or smelter.

Mine. 42, 43, 44. Engineering Design.

Preparation required: Mine. 3 or 11; Mec. 2, 3, 4.

Fall, Winter, and Spring Terms, 7 hours, 3 credits each.

ASSISTANT PROFESSOR MELLER AND MR. HALDEMAN

These courses apply to the design of head-frames, rock-houses, coal and ore bins, tipples, engine and boiler houses, bridges, etc.

Mine. 45, 46. Mining Costs.

Preparation required: Mine. 37 or 40.

Fall and Winter Terms, 3 hours, 3 credits each.

ASSISTANT PROFESSOR MELLER

These courses give a detailed study of the costs of mining in various parts of the mining world.

Mine. 47. Mine Valuation.

Preparation required: Mine. 46.

Spring Term, 7 hours, 3 credits.

ASSISTANT PROFESSOR MELLER

A study of the factors which assist the engineer in determining the value of a producing mine or a prospect; conduct of the examination; report; etc.

Mine. 48, 49, 50, 51. Mining Laboratory and Design.

Fall, Winter, Spring, and Summer Terms, 6 to 36 hours, 2 to 12 credits each.

ASSISTANT PROFESSOR MELLER AND MR. HALDEMAN

Mine. 52, 53, 54, 55. Mining Laboratory and Design.

Fall, Winter, Spring, and Summer Terms, 6 to 36 hours, 2 to 12 credits each.

ASSISTANT PROFESSOR MELLER AND MR. HALDEMAN

Mine. 56, 57, 58, 59. Mining Laboratory and Design.

Fall, Winter, Spring, and Summer Terms, 6 to 36 hours, 2 to 12 credits each.

ASSISTANT PROFESSOR MELLER AND MR. HALDEMAN

Mine. 60, 61, 62, 63. Mining Laboratory and Design.

Fall, Winter, Spring, and Summer Terms, 6 to 36 hours, 2 to 12 credits each.

ASSISTANT PROFESSOR MELLER AND MR. HALDEMAN

Mine. 64. Strength of Materials.

Preparation required: M. Geol. 4.

Taken with Mec. 2, 3.

Winter Term, 3 hours, 3 credits.

ASSISTANT PROFESSOR MELLER

Mine. 65, 66, 67, 68. Practical Work in Mining.

Preparation required: Mine 1 and 2, or 11.

13 weeks, 18 credits.

Mine. 69. Elements of Mining.

Fall Term, 3 hours, 3 credits.

7:30 to 9 P. M.

ASSISTANT PROFESSOR MELLER

Mine. 70. Methods of Coal Mining.

Winter Term, 3 hours, 3 credits.

7:30 to 9 P. M.

MR. HALDEMAN

Mine. 71. Ore Mining Methods.

Spring Term, 3 hours, 3 credits.

7:30 to 9 P. M.

ASSISTANT PROFESSOR MELLER

Mine. 72. Mining Trip.

Last Half Spring Term, 6 weeks, 12 credits.

An extended trip, lasting nearly six weeks, is taken to the Lake Superior iron and copper districts, or to other mining districts as may

be selected from time to time, for the purpose of studying metal mining methods.

Familiarity with coal mining methods in Pennsylvania, Ohio, and West Virginia will be gained through short visits, arranged at suitable intervals throughout the second and third years.

Mine. 73, 74, 75. Seminar.

Fall, Winter, and Spring Terms, 2 hours, 2 credits each.

Meetings are held twice a week for the discussion of current mining and engineering topics. Assignments, to be worked up outside of class, are made from time to time.

GRADUATE WORK

ASSISTANT PROFESSOR MELLER AND MR. HALDEMAN

Each of these subjects is taken from 6 to 60 hours a week with from 2 to 20 credits for each term of the year.

Mine. 301, 302, 303, 304. Research Work upon Mining.

Preparation required: Mine. 1-11.

Mine. 305, 306, 307, 308. Research Work upon Coal Mining.

Preparation required: Mine. 1-10.

Mine. 309, 310, 311, 312. Research Work upon Coal Mining Machinery.

Preparation required: Mine. 4, 5, 6.

Mine. 313, 314, 315, 316. Research Work upon Metal Mining Machinery.

Preparation required: Mine. 11, 13, 14, 15.

Mine. 317, 318, 319, 320. Research Work upon Mine Gases.

Preparation required: Mine. 7, 8, 9, 10.

Mine. 321, 322, 323, 324. Research Work upon Mine Ventilation.

Preparation required: Mine. 7, 8, 9, 10.

Mine. 325, 326, 327, 328. Research Work upon Mine Lighting.

Preparation required: Mine. 7, 8, 9, 10.

Mine. 329, 330, 331, 332. Research Work upon Metal Mining.

Preparation required: Mine. 1, 11, 13-25.

Mine. 333, 334, 335, 336. Research Work in Mining for Petroleum.

Natural Gas, Asphaltum, and other Hydrocarbons.

Preparation required: Mine. 12.

Mine. 337, 338, 339, 340. Research Work in Prospecting and Boring.

Preparation required: Mine. 13.

Mine. 341, 342, 343, 344. Research Work in Shaft Sinking.

Preparation required: Mine. 14.

- Mine. 345, 346, 347, 348. Research Work upon Mine Timber and other Supporting Material.
Preparation required: Mine. 16; M. Geol. 4.
- Mine. 349, 350, 351, 352. Research Work upon the Method of Supporting Excavations.
Preparation required: Mine. 16.
- Mine. 353, 354, 355, 356. Research Work upon Power Generation and Transmission.
Preparation required: Mine. 18.
- Mine. 357, 358, 359, 360. Research Work upon the use of Compressed Air in Mining.
Preparation required: Mine. 19.
- Mine. 361, 363, 363, 364. Research Work upon Electricity Applied to Mining.
Preparation required: Mine. 20.
- Mine. 365, 366, 367, 368. Research Work upon Haulage Methods and Machinery.
Preparation required: Mine. 21.
- Mine. 369, 370, 371, 372. Research Work upon Hoisting and Hoisting Appliances.
Preparation required: Mine. 22.
- Mine. 373, 374, 375, 376. Research Work upon Mine Drainage.
Preparation required: Mine. 23.
- Mine. 377, 378, 379, 380. Research Work upon Pumps and Pumping Machinery.
Preparation required: Mine. 24.
- Mine. 381, 382, 383, 384. Research Work upon Mine Explosives—Their Care and Use.
Preparation required: Mine. 25.
- Mine. 385, 386, 387, 388. Research Work upon First Aid to the Injured.
Preparation required: Mine. 26, 27, 29, 30; or 28, 31.
- Mine. 389, 390, 391, 392. Research Work upon Deep Mining.
Preparation required: Mine. 33.
- Mine. 393, 394, 395, 396. Research Work upon Placer and Hydraulic Mining and Dredging.
Preparation required: Mine. 34.
- Mine. 397, 398, 399, 400. Research Work upon the Best Methods of Laying out Surface and Underground Plants.
Preparation required: Mine. 35, 36.

Mine. 401, 402, 403, 404. Research Work upon the Best Methods in the Exploitation and Development of Coal Properties.

Preparation required: Mine. 37, 38, or Mine. 39.

Mine. 405, 406, 407, 408. Research Work upon the Best Methods in the Exploitation and Development of Metal Mines.

Preparation required: Mine. 40, 41.

Mine. 409, 410, 411, 412. Research Work upon Mining Costs.

Preparation required: Mine. 45, 46.

Mine. 413, 414, 415, 416. Research Work upon Mine Valuation.

Preparation required: Mine. 47.

Mine 2-64, and Mine 72 are intended for Graduates as well as for Undergraduates.

See Part IX. of the University Catalog.

VII. MINING ECONOMICS

UNDERGRADUATE WORK

PROFESSOR BACK, ASSISTANT PROFESSOR MELLER, AND

MESSRS. HALDEMAN AND CONRAD

M. Ec. 1, 2, 3. Principles of Mining Economics.

Preparation required: Mine. 1, and 2, 3.

Fall, Winter, and Spring or Summer Terms, 2 hours, 2 credits each.

PROFESSOR BECK

The courses in M. Ec. 1, 2, 3 are planned to give the student a brief resumé of economic theory and include a study of the present-day economic problems of wages, labor unions, trusts, and monopolies, currency, banking, transportation, tariff investigations, and social legislation. The courses are designed for technical students; the principles and problems involved will be treated from the mining point of view and so there will be considered at length such subjects as the rent of mines, conservation of mineral resources, exhaustion of mineral resources, the economic importance of mineral resources, the policy of Congress with reference to mineral lands, etc.

M. Ec. 4, 5, 6. Mine Management.

Preparation required: M. Ec. 1, 2, 3.

Fall, Winter, and Spring or Summer Terms, 2 hours, 2 credits each.

ASSISTANT PROFESSOR MELLER

It is not advisable for any student to limit his preparation for a life work to technical subjects. The scientific man must also be a practical business man. Courses M. Ec. 4, 5, 6 treat of mining operations from the standpoint of the business manager and are indispensable to those students intending to engage in executive work. There is also taken up the profitableness of inaugurating mining operations under prescribed

transportation conditions, with ore of a certain character; the problem of adequate labor supply, wages, superintendence, and housing; the use of machinery and the economic efficiency of particular machinery; the marketing of the output; and the purchase of supplies.

M. Ec. 7, 8, 9. Mining Corporation and Finance.

Preparation required: M. Ec. 1, 2, 3.

Fall, Winter, and Spring or Summer Terms, 2 hours, 2 credits each.

PROFESSOR BECK

Courses M. Ec. 7, 8, 9 are a study of the financial organization and management of mining corporations; the nature of a corporation and the legal methods of corporate dealings, the financial officers and their duties; promotion and flotation of mining corporations; the underwriter; the acquisition of new capital; the correct dividend policy; the different kinds of corporate securities; the consolidation of mining corporations with particular reference to the holding company; the financial features of mining leases; receiverships; dissolutions; reorganizations; the practice of effecting a reorganization; syndicate operations; etc.

M. Ec. 10, 11, 12. Mining Securities and Investments.

Preparation required: M. Ec. 1, 2, 3, 7, 8, 9.

Fall, Winter, and Spring or Summer Terms, 2 hours, 2 credits each.

PROFESSOR BECK

Courses M. Ec. 10, 11, 12, are continuations in large part of the study of the financial operations of mining companies. The character of the securities offered is more closely studied and so also there is studied the values underlying the securities. The effort is made to develop the power of critical analysis of mining securities so that a conservative estimate may be made of the value of such securities. The outstanding securities of a number of mining companies will be examined and analyzed.

M. Ec. 13, 14, 15. Mine Accounts.

Preparation required: Mine. 1 and 2 and 3 or 11.

Fall, Winter, and Spring or Summer Terms, 2 hours, 2 credits each.

MR. CONRAD

M. Ec. 16, 17, 18. Mine Labor Problems.

Preparation required: M. Ec. 1, 2, 3.

Fall, Winter, and Spring or Summer Terms, 2 hours, 2 credits each.

MR. CONRAD

M. Ec. 19, 20, 21. Mine Legislation.

Preparation required: M. Ec. 1, 2, 3.

Fall, Winter, and Spring or Summer Terms, 2 hours, 2 credits each.

PROFESSOR BECK

M. Ec. 22, 23, 24. The Mineral Industries.

Preparation required: Mine 1 and 2 and 3 or 11; M. Ec. 1, 2, 3.

Fall, Winter, and Spring or Summer Terms, 2 hours, 2 credits each.

MR. CONRAD

M. Ec. 25, 26, 27. The Coal Industry.

Preparation required: Mine 1, 2, 3; M. Ec. 1, 2, 3, 4, 5, 6, 16, 17, 18.
Fall, Winter, and Spring or Summer Terms, 2 hours, 2 credits each.

MR. HALDEMAN

M. Ec. 28, 29, 30. The Gold and Silver Industry.

Preparation required: Mine 1, 11, 41; M. Ec. 1, 2, 3, 4, 5, 6, 16, 17, 18.
Fall, Winter, and Spring or Summer Terms, 2 hours, 2 credits each.

ASSISTANT PROFESSOR MELLER

M. Ec. 31, 32, 33. The Copper Industry.

Preparation required: Mine 1, 11, 41; M. Ec. 1, 2, 3, 4, 5, 6, 16, 17, 18.
Fall, Winter, and Spring or Summer Terms, 2 hours, 2 credits each.

ASSISTANT PROFESSOR MELLER

M. Ec. 34, 35, 36. The Iron and Steel Industries.

Preparation required: Mine. 1, 11; M. Ec. 1, 2, 3, 4, 5, 6, 16, 17, 18.
Fall, Winter, and Spring or Summer Terms, 2 hours, 2 credits each.

MR. CONRAD

M. Ec. 37, 38, 39. Quarrying Industries.

Preparation required: Mine. 1, 11; M. Ec. 1, 2, 3, 4, 5, 6, 16, 17, 18.
Fall, Winter, and Spring, or Summer Terms, 2 hours, 2 credits each.

MR. CONRAD

GRADUATE WORK

PROFESSOR BECK AND MESSRS. HALDEMAN, CONRAD, AND MELLER.

These subjects can be taken from 1, 2, 3, or 4 terms a year, 3 to 60 hours a week, with from 1 to 20 credits a term, and for one or more years. For convenience in registration each term is given a separate number.

M. Ec. 301, 302, 303, 304. Research Work in Mining Economics.

Preparation required: M. Ec. 1, 2, 3.

M. Ec. 305, 306, 307, 308. Study and Investigation of Mine Management.

Preparation required: M. Ec. 4, 5, 6.

M. Ec. 309, 310, 311, 312. Research Work in Mining Corporations and Finance.

Preparation required: M. Ec. 7, 8, 9.

M. Ec. 313, 314, 315, 316. Study and Investigation of Mining Securities and Investments.

Preparation required: M. Ec. 10, 11, 12.

M. Ec. 317, 318, 319, 320. Study and Investigations of Mine Accounts and Development of Methods.

Preparation required: M. Ec. 13, 14, 15.

M. Ec. 321, 322, 323, 324. Research Work in Mine Labor Problems.

Preparation required: M. Ec. 16, 17, 18.

- M. Ec. 325, 326, 327, 328. Critical Study of Mine Legislation.
Preparation required: M. Ec. 19, 20, 21.
- M. Ec. 329, 330, 331, 332. Research Work in the Mineral Industries.
Preparation required: M. Ec. 22, 23, 24.
- M. Ec. 333, 334, 335, 336. Research Work in the Coal Industry.
Preparation required: M. Ec. 25, 26, 27.
- M. Ec. 337, 338, 339, 340. Research Work in the Gold and Silver Industry.
Preparation required: M. Ec. 28, 29, 30.
- M. Ec. 341, 342, 343, 344. Research Work in the Copper Industry.
Preparation required: M. Ec. 31, 32, 33.
- M. Ec. 345, 346, 347, 348. Research Work in the Iron and Steel Industries.
Preparation required: M. Ec. 34, 35, 36.
- M. Ec. 349, 350, 351, 352. Research Work in the Quarrying Industries.
Preparation required: M. Ec. 37, 38, 39.
M. Ec. 1 to 39 are intended for Graduate students also.
See University Catalog Part IX.

VIII. MINING (ECONOMIC) GEOLOGY UNDERGRADUATE WORK

DEAN WADSWORTH AND MR. LEIGHTON

- M. Geol. 1. The Principles of Mining (Economic) Geology.
Preparation required: Min. 3, 4; Geol. 3, 4.
Taken with Min. 5.
Spring Term, 3 hours, 3 credits.

DEAN WADSWORTH

In M. Geol. 1 is taken up the classification of the Utilites or the useful mineral or geological products, their origin, mode of occurrence, uses, associations, and methods of prospecting. It gives an elementary survey of the entire field and serves as an introduction to the various other subjects of Mining Geology given in the School of Mines, including the Mineral Wealth of North America, M. Geol. 5, 6, 7. The instruction is given by lectures and various texts. ffl

- M. Geol. 2. Principles of Mining Geology.
Preparation required: Min. 3, 4, 5; Geol. 3, 4, or for outside students good courses in Mineralogy and Geology.
Fall Term, 3 hours, 3 credits. Twice a week, 7:30 to 9 P. M.—DEAN WADSWORTH.

This course is the same as M. Geol. 1, but adapted to the students taking evening work. It will therefore be more or less varied from time to time according to the class.

M. Geol. 3. Principles of Mining Geology.

Preparation required: Min. 3, 4, 5; Geol. 3, 4, or an equivalent.
Summer Term, 3 hours, 3 credits.

DEAN WADSWORTH

This course is intended to cover the general principles of Mining (Economic) Geology for teachers and others who may be in attendance during the Summer Term. It will cover Prospecting for Mineral Deposits, their Classification, Occurrence, Properties, and Uses. The instruction will be given by lectures and the use of various texts. The above requirements are for the regular students who substitute M. Geol. 3 for M. Geol. 1. Teachers and others who can only attend during the Summer Term are allowed to elect this subject without the requisite preparation if they can follow the course understandingly.

M. Geol. 4. Materials of Construction.

Preparation required: M. Geol. 1.

Fall Term, 3 hours, 3 credits.

Taken with M. Geol. 91.

DEAN WADSWORTH AND MR. LEIGHTON

M. Geol. 4 treats of the materials used in building and engineering construction including the various woods and mine timbers. This course is largely descriptive and consists of lectures and text-book work with the accompanying laboratory work. It is to be followed by Mine 77, Strength of Construction Materials and Mec. 3 or Laboratory Work upon these Materials.

M. Geol. 5, 6, 7. Mineral Wealth of North America.

Preparation required: Min. 3, 4, 5; Geol. 3, 4; M. Geol. 1, or 2, or 3.

Fall, Winter, and Spring Terms, 2 hours, 2 credits each.

MR. LEIGHTON

These courses take up the general discussion of the Mineral Deposits of North America, continuing and extending the instruction given in M. Geol. 1. The work will be given by lectures and quizzes upon Ries' *Economic Geology of the United States* with the collateral reading of Kemp's *Ore Deposits of the United States*, Reports of the United States Geological Survey, and the geological surveys of various states, and countries of North America.

These courses are especially recommended to the student who wishes a general idea of the subject but does not wish to specialize in it. They should be taken also by all those who wish to continue their work in Mining Geology in other courses given in the school.

M. Geol. 8, 9, 10. Metallites or Metalliferous Deposits.

Preparation required: Min. 3, 4, 5; Geol. 3, 4; M. Geol. 1, or 2, or 3 and 5, 6, 7; or taken with M. Geol. 5, 6, 7.

Fall, Winter, and Spring, or Summer Terms, 2 hours, 2 credits each.

DEAN WADSWORTH

These courses cover an extended discussion of the various Metalliferous Deposits of the world, their occurrence, associations, and the

principles involved. The work presupposes a thorough acquaintance with minerals, rocks, and Physical and Chemical Geology.

The instruction will be given by lectures, discussions, and study of various texts principally Beck-Weed's *Theories of Ore Deposits and Geological Survey Reports*.

M. Geol. 11, 12, 13. The Genesis of Mineral Deposits.

Preparation required: M. Geol. 1 and 2, or 3, and 5, 6, 7; Geol. 10 to 15; Pet. 1 to 6, 10 to 15.

Preceded by or taken with Pet. 7, 8, 9, 16, 17, 18.

Fall, Winter and Spring, or Summer Terms, 2 hours, 2 credits each.

DEAN WADSWORTH

These courses treat of the theories relating to the Mineral Deposits of the World. The instruction is given by lectures, quizzes, and by discussion of various texts principally the Genesis of Ore Deposits and other papers belonging to the Transactions of the American Institute of Mining Engineers, the United States Geological Survey, etc.

M. Geol. 14, 15, 16. Clays—Their Origin, Occurrence, Properties, and Uses.

Preparation required: M. Geol. 1.

Fall, Winter, and Spring Terms, 2 hours, 2 credits each.

MR. LEIGHTON

In M. Geol. 14, 15, and 16 use is made of Ries' book on "*Clays, Their Origin, Properties, and Uses*", supplemented by lectures on various branches of the clay working industry.

M. Geol. 17, 18, 19. Lime, Plaster, and Cement Materials—Their Occurrence, Properties, and Uses.

Preparation required: M. Geol. 1.

Fall, Winter, and Spring Terms, 2 hours, 2 credits each.

MR. LEIGHTON

M. Geol. 20. Materials for Glazes, Enamels, Colors, Fluxes, and Glass-Making—Their Occurrence, Properties, and Uses.

Preparation required: M. Geol. 1.

Fall Term, 2 hours, 2 credits.

MR. LEIGHTON

M. Geol. 21, 22, 23. Precious Stones or Gems—Their Origin, Occurrence, Properties, Determination, and Uses.

Preparation required: Min. 3, 4, 5, 33, 34, 35; Geol. 3, 4, 10-15; M. Geol. 1; or Pet. 1-6, 10-15.

Taken with Pet. 7, 8, 9.

Fall, Winter, and Spring, or Summer Terms, 2 hours, 2 credits each.

DEAN WADSWORTH

M. Geol. 24, 25, 26. Coal and Peat Deposits—Their Origin, Occurrence, Distribution, Exploitation, Properties, and Uses.

Preparation required: Geol. 1 or 2 or 3 and 4 or 9; Mine. 1; M. Geol. 1.

Fall, Winter, and Spring Terms, 2 hours, 2 credits each.

MR. LEIGHTON

M. Geol. 24, 25, and 26 consist mainly of lectures on the later theories for the origin of coals, their classification, and composition, the stratigraphy of coal beds, structural irregularities, followed by a study of the distribution of coals in the United States, with description of the various fields.

M. Geol. 27, 28, 29. Petroleum, Natural Gas, Asphaltum, and other Hydrocarbons.

Preparation required: Mine. 1; M. Geol. 24, 25, 26, or taken with M. Geol. 24, 25, and 26.

Fall, Winter, and Spring Terms, 2 hours, 2 credits each.

MR. LEIGHTON

The subjects M. Geol. 27, 28, and 29 treat of the origin, mode of occurrence, distribution, exploitation, properties, and uses of Petroleum and Natural Gas. They especially dwell upon their occurrence in Pennsylvania and elsewhere in the United States.

M. Geol. 30, 31, 32. Mineral Fertilizers—Their Origin, Occurrence, Distribution, Exploitation, Properties, and Uses.

Preparation required: Geol. 3, 4, or 9; M. Geol. 1; Mine. 1 or with Mine 1.

Fall, Winter, and Spring Terms, 2 hours, 2 credits each.

MR. LEIGHTON

M. Geol. 33, 34, 35. Iron and Manganese Deposits.

Preparation required: Geol. 10-15; M. Geol. 1, 5-7; Mine 1, 11; Pet. 1-6, 10-15.

Taken with Pet. 7, 8, 9, 16-18; M. Geol. 11, 12, 13.

Fall, Winter, and Spring, or Summer Terms, 2 hours, 2 credits each.

DEAN WADSWORTH

M. Geol. 33, 34, and 35 treat of the origin of Iron and Manganese Ores, their mode of occurrence, methods of prospecting for them, their distribution, properties, and uses, particular attention being paid to the deposits in the United States and Canada.

M. Geol. 36, 37, 38. Saline and Gypsum Deposits—Origin, Occurrence, Properties, and Uses.

Preparation required: Mine. 1, 11; M. Geol. 1.

Fall, Winter, and Spring Terms, 2 hours, 2 credits each.

MR. LEIGHTON

M. Geol. 39, 40, 41. Copper Deposits.

Preparation required: Geol. 10-15; Mine. 1, 11; M. Geol. 1, 5, 6, 7; Pet. 1-3, 10-12.

Preceded by or taken with Pet. 4-6, 13-15; Geol. 13, 14, 15.

Fall, Winter, and Spring, or Summer Terms, 2 hours, 2 credits each.

DEAN WADSWORTH

M. Geol. 42, 43, 44. Gold, Silver, and Silver Lead Deposits.

Preparation required: Geol. 10-15; M. Geol. 1, 5, 6, 7; Pet. 1-6, 10-15; Mine 1, 11.

Preceded by or taken with Pet. 7, 8, 9, 16-18; M. Geol. 11-13.

Fall, Winter, and Spring, or Summer Terms, 2 hours, 2 credits each.

DEAN WADSWORTH

M. Geol. 45, 46, 47. Lead and Zinc Deposits.

Preparation required: Geol. 10-12; Mine. 1, 11; M. Geol. 1, 5, 6, 7.

Taken with Geol. 13-15.

Fall, Winter, and Spring, or Summer Terms, 2 hours, 2 credits each.

DEAN WADSWORTH

M. Geol. 48, 49, 50. Chromium, Bismuth, Nickel, Cobalt, Platinum, and other Minor Deposits.

Preparation required: Geol. 10-15; Mine. 1, 11; Pet. 1-6, 10-15; M. Geol. 5-7.

Taken with M. Geol. 11-13; Pet. 7-9, 16-18.

Fall, Winter, and Spring, or Summer Terms, 2 hours, 2 credits each.

DEAN WADSWORTH

M. Geol. 51, 52, 53. Aluminum, Sulphur, Vanadium, Barium, and other Minor Deposits.

Preparation required: Geol. 10-15; Min. 3, 4, 5; Mine. 1, 11; M. Geol. 5-7; Pet. 1-6, 10-15.

Taken with M. Geol. 11, 12, 13.

Fall, Spring and Summer Terms, 2 hours, 2 credits each.

DEAN WADSWORTH

M. Geol. 54. Mining Geology of Abrasive Materials—Their Occurrence, Properties, and Uses.

Preparation required: Geol. 3, 4; M. Geol. 1; Min. 3, 4, 5.

Fall Term, 2 hours, 2 credits.

MR. LEIGHTON

M. Geol. 55. Mining Geology of Refractory Materials—Occurrence Properties, and Uses.

Preparation required: Min. 3-5; Geol. 3, 4; M. Geol. 1.

Winter Term, 2 hours, 2 credits.

MR. LEIGHTON

M. Geol. 56. Building Stones and Road Materials.

Preparation required: Min. 3, 4, 5; Geol. 3 and 4; M. Geol. 1, 2, or 3.

Preceded by or taken with Pet. 6, 15.

Winter Term, 3 hours, 3 credits.

MR. LEIGHTON

M. Geol. 57. Mining Geology of Mineral Pigments, Lubricants, Illustrative, and Fluxing Materials.

Preparation required: M. Geol. 1; Min. 3, 4, 5; Geol. 3, 4.

Winter Term, 2 hours, 2 credits.

MR. LEIGHTON

M. Geol. 58. Mining Geology of Pyrotechnic Materials and Mineral Medicines.

Preparation required: M. Geol. 1; Min. 3, 4, 5; Geol. 3, 4.
Spring Term, 2 hours, 2 credits.

DEAN WADSWORTH

M. Geol. 59, 60, 61. Mining Geology of Water.

Preparation required: Geol. 3, 4; M. Geol. 1.

Fall or Summer Terms, 2 hours, 2 credits each.

MR. LEIGHTON

M. Geol. 62, 63, 64. Mining Geology of Chemical Materials.

Preparation required: Ch. 1, 2, 8; Geol. 3, 4; M. Geol. 1; Min. 3, 4, 5.

Fall, Winter, and Spring Terms, 2 hours, 2 credits each.

MR. LEIGHTON

M. Geol. 65, 66, 67. Mining Geology of Tin and Mercury Deposits.

Preparation required: Min. 3, 4, 5; Geol. 10-15; M. Geol. 5-7; Pet. 1-3, 10-12.

Preceded by or taken with Geol. 13, 14, 15; Pet. 3, 4, 5, 13, 14, 15.

Fall, Winter, and Spring, or Summer Terms, 2 hours, 2 credits, each.

DEAN WADSWORTH

M. Geol. 68, 69, 70. Mining Geology of Canada.

Preparation required: M. Geol. 1, 5, 6, 7; Geol. 10-15.

Taken with M. Geol. 11, 12, 13.

Fall, Winter, and Spring, or Summer Terms, 2 hours, 2 credits each.

M. Geol. 71, 72, 73. Mining Geology of Mexico and Central America.

Preparation required: Geol. 10-15; M. Geol. 5, 6, 7.

Taken with M. Geol. 11, 12, 13.

Fall, Winter, and Spring, or Summer Terms, 2 hours, 2 credits each.

M. Geol. 74, 75, 76. Mining Geology of South America.

Preparation required: M. Geol. 5, 6, 7; Geol. 10-15.

Taken with M. Geol. 11, 12, 13.

Fall, Winter, and Spring, or Summer Terms, 2 hours, 2 credits each.

M. Geol. 77, 78, 79. Mining Geology of Europe.

Preparation required: M. Geol. 5, 6, 7; Geol. 10-15.

Taken with M. Geol. 11, 12, 13.

Fall, Winter, and Spring, or Summer Terms, 2 hours, 2 credits each.

M. Geol. 80, 81, 82. Mining Geology of Asia.

Preparation required: M. Geol. 5, 6, 7; Geol. 10-15.

Taken with M. Geol. 11, 12, 13.

Fall, Winter, and Spring, or Summer Terms, 2 hours, 2 credits each.

M. Geol. 83, 84, 85. Mining Geology of Australia.

Preparation required: M. Geol. 5, 6, 7; Geol. 10-15.

Taken with M. Geol. 11, 12, 13.

Fall, Winter, and Spring, or Summer Terms, 2 hours, 2 credits each.

M. Geol. 86, 87, 88. Mining Geology of Africa.

Preparation required: M. Geol. 5, 6, 7; Geol. 10-15.

Taken with M. Geol. 11, 12, 13.

Fall, Winter, and Spring, or Summer Terms, 2 hours, 2 credits each.

M. Geol. 89, 90. Mining Geological Laboratory.

Taken with M. Geol. 1, 3.

Spring and Summer Terms, 3 to 60 hours, 1 to 20 credits each.

MR. LEIGHTON

M. Geol. 91. Mining Geological Laboratory.

Taken with M. Geol. 4.

Fall Term, 6 hours, 2 credits.

MR. LEIGHTON

M. Geol. 92, 93, 94. Mining Geological Laboratory.

Taken with M. Geol. 5, 6, 7; or 14, 15, 16; or 17, 18, 19; or 20; or 24, 25, 26; or 30, 31, 32; or 54; or 55.

Fall, Winter, and Spring Terms, 3 to 60 hours, 1 to 20 credits each.

MR. LEIGHTON

M. Geol. 95, 96, 97. Mining Geological Laboratory.

Taken with M. Geol. 27-29; or 36-38; or 57 or 58; or 59-61; or 62-64.

Fall, Winter, and Spring Terms, 3 to 60 hours, 1 to 20 credits each.

MR. LEIGHTON

M. Geol. 98, 99, 100. Mining Geological Laboratory.

Taken with M. Geol. 21-23; or 33-35; or 39-41; or 42-44; or 45-47; or 48, 49, 50; or 51, 52, 53; or 56; or 65, 66, 67; or 68, 69, 70; or 71, 72, 73; or 74, 75, 76; or 77, 78, 79; or 80, 81, 82; or 83, 84, 85.

Fall, Spring, and Summer Terms, 3 to 60 hours, 1 to 20 credits.

DEAN WADSWORTH

M. Geol. 101. Conservation of Mineral Resources.

Preparation required: M. Geol. 1, 5, 6, 7.

Spring Term, 2 hours, 2 credits.

DEAN WADSWORTH

M. Geol. 102, 103, 104, 105. Practical (Co-operative) Work in Mining Geology:

13 weeks, 18 credits each.

M. Geol. 106, 107. Mineral Wealth of North America.

Preparation required: Min. 3, 4, 5; Geol. 3, 4; M. Geol. 1 or in the case of outside students, good general courses in Mineralogy and Geology.

Winter, and Spring Terms, 3 hours, 3 credits each, 7:30 to 9 P. M.

MR. LEIGHTON

In this course there are taken up the general properties, occurrence and uses of the commercially valuable mineral substances, both metallic and non-metallic, the instruction being given by means of Ries' *Economic Geology of the United States* as a text-book, supplanted by explanatory lectures and discussions, and the use of words relating to other parts of the continent.

GRADUATE WORK

DEAN WADSWORTH AND MR. LEIGHTON

All the subjects below are taken from 6 to 60 hours each week, and for 1 to 4 terms a year, with from 2 to 20 credits for each term of the year. They can be taken as many years as it is desirable.

M. Geol. 301, 302, 303, 304. Research Work upon the Principles of Mining or Economic Geology.

Preparation required: M. Geol. 11, 12, 13.

M. Geol. 305, 306, 307, 308. Research Work upon the Memetallites or Non-Metalliferous Deposits.

Preparation required: M. Geol. 24-29.

M. Geol. 309, 310, 311, 312. Research Work upon Building and Ornamental Stones and Road Materials.

Preparation required: M. Geol. 56.

M. Geol. 313, 314, 315, 316. Research Work upon the Metallites or Metalliferous Deposits.

Preparation required: M. Geol. 5-10.

M. Geol. 317, 318, 319, 320. Research Work upon the Mineral Deposits of the United States.

Preparation required: M. Geol. 8, 9, 10.

M. Geol. 321, 322, 323, 324. Research Work upon the Genesis of Mineral Deposits.

Preparation required: M. Geol. 11, 12, 13.

M. Geol. 325, 326, 327, 328. Research Work upon the Clays—Their Origin, Occurrence, Properties, and Uses.

Preparation required: M. Geol. 14, 15, 16.

M. Geol. 329, 330, 331, 332. Research Work upon the Lime, Plaster, and Cement Materials—Their Occurrence, Properties, and Uses.

Preparation required: M. Geol. 17, 18, 19.

M. Geol. 333, 334, 335, 336. Research Work upon the Materials for Glazes, Enamels, Colors, Fluxes, and Glass-Making—Their Occurrence, Properties, and Uses.

Preparation required: M. Geol. 20.

M. Geol. 337, 338, 339, 340. Research Work upon Coal and Peat Deposits—Their Origin, Distribution, Exploitation, Properties, and Uses.

Preparation required: M. Geol. 24, 25, 26.

M. Geol. 341, 342, 343, 344. Research Work upon Petroleum, Natural Gas, Asphaltum, and other Hydrocarbons.

Preparation required: M. Geol. 27, 28, 29.

- M. Geol. 345, 346, 347, 348. Research Work upon Mineral Fertilizers—
Their Occurrence, Origin, Distribution, Exploitation, Properties, and
Uses.
Preparation required: M. Geol. 30, 31, 32.
- M. Geol. 349, 350, 351, 352. Research Work upon Iron and Manganese
Deposits.
Preparation required: M. Geol. 33, 34, 35.
- M. Geol. 353, 354, 355, 356. Research Work upon Saline and Gypsum
Deposits—Their Origin, Occurrence, Properties, and Uses.
Preparation required: M. Geol. 36, 37, 38.
- M. Geol. 357, 358, 359, 360. Research Work upon the Copper Deposits.
Preparation required: M. Geol. 39, 40, 41.
- M. Geol. 361, 362, 363, 364. Research Work upon Gold, Silver, and
Silver Lead Deposits.
Preparation required: M. Geol. 42, 43, 44.
- M. Geol. 365, 366, 367, 368. Research Work upon Lead and Zinc Deposits.
Preparation required: M. Geol. 45, 46, 47.
- M. Geol. 369, 370, 371, 372. Research Work upon the Mining Geology
of Chromium, Bismuth, Nickel, Cobalt, Platinum, and other Minor
Deposits.
Preparation required: M. Geol. 48, 49, 50.
- M. Geol. 373, 374, 375, 376. Research Work upon Aluminum, Sulphur,
Vanadium, Barium, and other Minor Deposits.
Preparation required: M. Geol. 51, 52, 53.
- M. Geol. 377, 378, 379, 380. Research Work upon the Mining Geology
of Abrasive Materials—Their Occurrence, Properties, and Uses.
Preparation required: M. Geol. 54.
- M. Geol. 381, 382, 383, 384. Research Work in the Mining Geology of Re-
fractory Materials—Their Occurrence, Properties, and Uses.
Preparation required: M. Geol. 55.
- M. Geol. 385, 386, 387, 388. Research Work in the Mining Geology of
Color, Illustrative, Friction, and Fluxing Materials.
Preparation required: M. Geol. 57.
- M. Geol. 389, 390, 391, 392. Research Work in the Mining Geology of
Pyrotechnic Materials, and Mineral Medicines.
Preparation required: M. Geol. 58.
- M. Geol. 393, 394, 395, 396. Research Work in the Mining Geology of
Water.
Preparation required: M. Geol. 59, 60, 61.
- M. Geol. 397, 398, 399, 400. Research Work in the Mining Geology of
Chemical Materials.
Preparation required: M. Geol. 62, 63, 64.

- M. Geol. 401, 402, 403, 404. Research Work in the Mining Geology of Tin and Mercury Deposits.
Preparation required: M. Geol. 65, 66, 67.
- M. Geol. 405, 406, 407, 408. Research Work in the Mining Geology of Canada.
Preparation required: M. Geol. 68, 69, 70.
- M. Geol. 409, 410, 411, 412. Research Work upon the Mining Geology of Mexico and Central America.
Preparation required: M. Geol. 71, 72, 73.
- M. Geol. 413, 414, 415, 416. Research Work upon the Mining Geology of South America.
Preparation required: M. Geol. 74, 75, 76.
- M. Geol. 417, 418, 419, 420. Research Work upon the Mining Geology of Europe.
Preparation required: M. Geol. 77, 78, 79.
- M. Geol. 421, 422, 423, 424. Research Work in the Mining Geology of Asia.
Preparation required: M. Geol. 80, 81, 82.
- M. Geol. 425, 426, 427, 428. Research Work in the Mining Geology of Australasia.
Preparation required: M. Geol. 83, 84, 85.
- M. Geol. 429, 430, 431, 432. Research Work in the Mining Geology of Africa.
Preparation required: M. Geol. 86, 87, 88.
- M. Geol. 433, 434, 435, 436. Research Work upon the Mining Geology of Gems.
Preparation required: M. Geol. 21, 22, 23.
- M. Geol. 5 to 87 are intended for Graduates as well as for Undergraduates.
See University Catalog Part IX.

IX. MINING LAW

UNDERGRADUATE WORK

PROFESSOR BECK AND MR. CONRAD

Law. 1. Principles of Law and Introduction to Mining Law.

Preparation required: M. Geol. 1; Mine, 1.

Fall Term, 2 hours, 2 credits.

This course is designed to be an introduction to the study of any branch of law. It includes a study of the organization of our judicial system, the relation of the federal and state courts, the province of the judge and the jury, the common law and the civil law, the difference between law and equity, statutory law, infancy, coverture, associations, the several branches of law, etc.

Law. 2, 3. General Mining Law.

Preparation required: Law. 1.

Winter and Spring Terms, 2 hours, 2 credits each.

In Law. 2 and 3 there is covered the field of mining law in as thorough a manner as the time permits. These two courses are given with Law 1 in such a manner as to supply the needs of those students who cannot give more than two hours a week for one year to this subject. To state the parts of Mining Law which are included in these courses would be to enumerate all its main topics. Most time will be devoted to the practical portions, such as the making of a valid location and the perfecting of the prospector's rights, the rights under mining leases, etc.

Law. 4, 5, 6. Mining Contracts and Specifications.

Preparation required: Law. 1, 2, 3.

Fall, Winter, and Spring Terms, 2 hours, 2 credits each.

A study of the essential elements of a contract, the capacity of parties to contracts, contracts of corporations, the performance or breach of contracts, their discharge. Proposals and specifications. Training in the preparation of contracts and specifications relating to the mining industry. Certain other legal subjects of practical importance are studied, such as negotiable investments, agency, torts, etc.

Law, 7, 8, 9. Advanced Mining Law.

Preparation required: Law. 1, 2, 3.

Fall, Winter, and Spring Terms, 2 hours, 2 credits each.

Law. 7, 8, 9 are courses carrying further the work begun in Law. 1, 2, 3. While in all the law courses great stress is laid upon the study of illustrative cases, such study is made a particular feature of these courses as also is the actual preparation of the various legal papers relating especially to mining.

Law. 10, 11, 12. Law Relating to Oil and Gas.

Preparation required: Law. 1, 2, 3.

Fall, Winter, and Spring Terms, 2 hours, 2 credits each.

Law. 13, 14, 15. Law Relating to Coal Mining.

Preparation required: Law. 1, 2, 3.

Fall, Winter, and Spring Terms, 2 hours, 2 credits each.

Law. 16, 17, 18. Law Relating to Metal Mining.

Preparation required: Law. 1, 2, 3.

Fall, Winter, and Spring Terms, 2 hours, 2 credits each.

Law. 19, 20, 21. Law of Mining Operations.

Preparation required: Law. 1, 2, 3, 4, 7, 8, 9.

Fall, Winter, and Spring Terms, 2 hours, 2 credits each.

Law. 22, 23, 24. Law of Negligence and Personal Injuries in Mines.

Preparation required: Law. 1, 2, 3, 4, 7, 8, 9.

Fall, Winter, and Spring Terms, 2 hours, 2 credits each.

Law. 25, 26, 27. Mining Laws of Great Britain.

Preparation required: Law. 1, 2, 3, 4, 7, 8, 9.

Fall, Winter, and Spring Terms, 2 hours, 2 credits each.

Law. 28, 29, 30. Mining Laws of Mexico and other Foreign Countries.

Preparation required: Law. 1, 2, 3, 4, 7, 8, 9.

Fall, Winter, and Spring Terms, 2 hours, 2 credits each.

GRADUATE WORK

PROFESSOR BECK AND MR. CONRAD

Each of the subjects below are taken one or more terms a year, from 6 to 60 hours a week, with 2 to 20 credits a term, and one or more years as desired.

Law. 301, 302, 303, 304. History of Mining Law.

Preparation required: Law. 1, 2, 3, 4, 7, 8, 9.

Law. 305, 306, 307, 308. Critical Study of Mining Law.

Preparation required: Law. 1, 2, 3, 4, 7, 8, 9.

Law. 309, 310, 311, 312. Education in Mining Law.

Preparation required: Law. 1, 2, 3, 4, 7, 8, 9.

Law. 313, 314, 315, 316. Critical Study of Law relating to Oil and Gas.

Preparation required: Law. 1, 2, 3, 4, 10, 11, 12.

Law. 317, 318, 319, 320. Critical Study of Law relating to Coal Mining.

Preparation required: Law. 1, 2, 3, 4, 13, 14, 15.

Law. 321, 322, 323, 324. Critical Study of Law relating to Metal Mining.

Preparation required: Law. 1, 2, 3, 4, 16, 17, 18.

Law. 325, 326, 327, 328. Critical Study of the Law of Negligence and Personal Injuries in Mines.

Preparation required: Law. 1, 2, 3, 4, 22, 23, 24.

Law. 329, 330, 331, 332. Research Work in Foreign Mining Laws.

Preparation required: Law. 1, 2, 3, 4, 7, 8, 9, 25, 26, 27, 28, 29, 30.

Law. 333, 334, 335, 336. Research Work for the Improvement of Mining Laws.

Preparation required: Law. 1-30.

Law. 1 to 30 are also intended for Graduates.

See University Catalog Part IX.

X. MINING SURVEYING UNDERGRADUATE WORK

ASSISTANT PROFESSOR MELLER AND MR. HALDEMAN

M. Sur. 1. Trips of Inspection.

Taken with Mine. 1.

Fall Term, 6 hours, 2 credits.

ASSISTANT PROFESSOR MELLER AND MR. HALDEMAN

M. Sur. 2, 3, 4. Mine Surveying.

Preparation required: Mat. 5, 6; Mine. 1; Sur. or C. E. 1.

Fall, Winter, and Spring, or Summer Terms, 12 hours, 4 credits each.

ASSISTANT PROFESSOR MELLER

M. Sur. 5, 6, 7. Mine Surveying.

Preparation required: M. Sur. 2, 3, 4, respectively.

Fall, Winter, and Spring, or Summer Terms, 12 hours, 4 credits each.

ASSISTANT PROFESSOR MELLER

M. Sur. 8, 9, 10. Mine Surveying.

Preparation required: M. Sur. 5, 6, 7, respectively.

Fall, Winter, and Spring, or Summer Terms, 12 hours, 4 credits each.

ASSISTANT PROFESSOR MELLER

Courses in M. Sur. 2 to 10 cover Mine Surveying in its various branches, including complete surface surveys of mining property, preliminary and official mining claim surveys; determination of strike, dip, etc.; determination of meridian by solar and stellar observations; connection of surface and underground surveys through vertical shafts, inclines and adits; underground traversing; mapping, etc.

M. Sur. 11. Complete Course in Mine Surveying.

Preparation required: Mat. 5, 6; Mine. 1.

Summer Term, 50 hours each week, 23 credits.

ASSISTANT PROFESSOR MELLER

The complete course in Mine Surveying is arranged for the Summer Term, and all students are advised to take it at that time. For the benefit of those who find it impossible to do so, courses Mine Surveying 2 to 10 are arranged to cover the same ground.

M. Sur. 12, 13, 14, 15. Practical Work in Mine Surveying.

Preparation required: M. Sur. 2-10.

13 weeks, 18 credits each.

GRADUATE WORK

ASSISTANT PROFESSOR MELLER AND MR. HALDEMAN

Each subject given below is taken from 6 to 60 hours a week giving from 2 to 20 credits each term of the year for as many terms and years as are given.

M. Sur. 301, 302, 303, 304. Research Work in Mining Surveying, Instruments, Methods, etc.

Preparation required: M. Sur. 2, 3, 4, and 6 or 7.

M. Sur. 305, 306, 307, 308. Research Work in the History of Mining Surveying.

Preparation required: M. Sur. 2, 3, 4, 5, and 6 or 7.

M. Sur. 309, 310, 311, 312. Critical Study of Education in Mining Surveying.

Preparation required: M. Sur. 2, 3, 4, 5, and 6 or 7.

See University Catalog Part IX.

XI. ORE DRESSING AND COAL WASHING

UNDERGRADUATE WORK

PROFESSOR GOODALE AND MR. RAY

Ore. 1, 2, 3. Principles of Ore Dressing.

Preparation required: Ch. 1; Min. 3, 4, 5.

Fall, Winter, and Spring, or Summer Terms, 3 hours, 3 credits each.

Ore. 1 to 3 cover the basic principles applying to ore dressing and coal washing, including crushing of ores, screening, jigging, classifying, table concentration, etc., etc. Ore. 1 covers the more general principles which every student in the School should know. Ore. 2 gives the more advanced work that metallurgical students should have.

Ore. 4, 5, 6. Gold and Silver Cyaniding and Milling.

Preparation required: Met. 1 or 2; Ore. 1, 2; Ch. 1, 2.

Fall, Winter, and Spring, or Summer Terms, 2 hours, 2 credits each.

Courses Ore. 4 to 6 cover the milling processes for gold and silver, including cyaniding the most important, chlorination, stamp milling, etc., etc.

Ore. 7, 8, 9. Coal Washing and Preparation for Market and Coking.

Preparation required: Ore. 1, 2; Met. 1 or 2.

Fall, Winter, and Spring, or Summer Terms, 2 hours, 2 credits.

Courses Ore. 7 to 9 cover the preparation by washing of both hard and soft coals. These subjects are of growing importance as the higher grade fuels become exhausted and we must depend on poorer grades that need to be cleaned before use.

Ore. 10, 11, 12. Special Problems in Ore Dressing.

Preparation required: Met. 1, 2; Ore. 1, 2, 3.

Fall, Winter, and Spring, or Summer Terms, 2 to 4 hours, 2 to 4 credits each.

Ore. 10 to 12 are designed to take up the study of some special phase of work in ore dressing, coal washing, etc., such as jigging, table concentration, classifying *versus* sizing, etc., etc. Suitable laboratory courses may well be elected with these courses.

Ore. 13, 14, 15. Ore Dressing Laboratory.

Taken with Ore. 1, 2, 3, or subsequently.

Fall, Winter, and Spring, or Summer Terms, 6 hours, 2 credits each.

Ore. 16, 17, 18. Ore Dressing Laboratory.

Preparation required: Ore. 13, 14, 15.

Taken with Ore. 4, 5, 6.

Fall, Winter, and Spring, or Summer Terms, 6 hours, 2 credits each.

Ore. 19, 20, 21. Ore Dressing Laboratory.

Preparation required: Ore. 13, 14, 15.

Taken with Ore. 10, 11, 12.

Fall, Winter, and Spring, or Summer Terms, 6 hours, 2 credits each.

Ore. 22, 23, 24. Ore Dressing Laboratory.

Taken with Ore. 13, 14, 15.

Fall, Winter, and Spring, or Summer Terms, 3 to 54 hours a week,
1 to 18 credits each.

Ore. 25, 26, 27. Ore Dressing Laboratory.

Taken with Ore. 16, 17, 18.

Fall, Winter, and Spring, or Summer Terms, 3 to 54 hours a week,
1 to 18 credits each.

Ore. 28, 29, 30. Ore Dressing Laboratory.

Taken with Ore. 19, 20, 21.

Fall, Winter, and Spring, or Summer Terms, 3 to 54 hours a week,
1 to 18 credits each.

Ore. 31, 32, 33. Coal Washing Laboratory.

Preparation required: Met. 1 or 2; Ore. 1; or

Taken with Met. 1 or 2 and Ore. 1.

Fall, Winter, and Spring, or Summer Terms, 6 hours, 2 credits each.

Ore. 34, 35, 36. Coal Washing Laboratory.

Preparation required: Ore. 31, 32, 33.

Taken with Ore. 7, 8, 9.

Fall, Winter, and Spring, or Summer Terms, 6 hours, 2 credits each.

Ore. 37, 38, 39. Coal Washing Laboratory.

Preparation required: Ore. 34, 35, 36.

Fall, Winter, and Spring, or Summer Terms, 6 hours, 2 credits each.

Ore. 40, 41, 42. Coal Washing Laboratory.

Taken with Ore. 31, 32, 33.

Fall, Winter, and Spring, or Summer Terms, 3 to 54 hours, 1 to 18
credits each.

Ore. 43, 44, 45. Coal Washing Laboratory.

Taken with Ore. 34, 35, 36.

Fall, Winter, and Spring, or Summer Terms, 3 to 54 hours a week,
1 to 18 credits each.

Ore. 46, 47, 48. Coal Washing Laboratory.

Taken with Ore. 37, 38, 39.

Fall, Winter, and Spring, or Summer Terms, 3 to 54 hours a week,
1 to 18 credits each.

Laboratory courses in Ore Dressing and Coal Washing are designed to give the student a thorough knowledge of the actual operations involved in the dressing of ores, coals, etc., together with control of the same by physical and chemical testing as necessary.

Ore. 49, 50, 51, 52. Practical Work in Ore Dressing.

Preparation required: Ore. 1, 2.

13 weeks, 18 credits.

Ore. 53, 54, 55, 56. Practical Work in Coal Washing and Preparation for Market.

Preparation required: Ore. 1, 2.

13 weeks, 18 credits.

Courses Ore. 49 to 56 gives the student an opportunity to work in various mills as a part of his course. A thesis covering the work accomplished is required on the completion of each period of consecutive similar work. The work may be done in any term or terms during the student's course, but it is necessary to arrange with the head of the department and the Dean prior to undertaking the courses so that the work selected may be of satisfactory nature.

Ore. 57, 58, 59, 60. Ore Dressing Trips or Visits of Inspection to Ore Dressing and Coal Washing Plants.

Fall, Winter, and Spring, or Summer Terms, 6 to 12 hours a week, 2 to 4 credits each.

GRADUATE WORK

PROFESSOR GOODALE AND MR. RAY

Each subject given below is taken from 1 to 4 terms a year and from 3 to 60 hours a week for one or more years, giving from 1 to 20 credits each term of the year.

Ore. 301, 302, 303, 304. Research Work in Ore Dressing.

Preparation required: Ore. 1, 2, 3, 13, 14, 15.

Ore. 305, 306, 307, 308. Research Work in Coal Washing.

Preparation required: Ore. 7, 8, 9, 34, 35, 36.

Ore. 309, 310, 311, 312. Research Work in Gold and Silver Milling.

Preparation required: Ore. 4, 5, 6, 16, 17, 18.

Ore. 313, 314, 315, 316. Research Work in the History of Ore Dressing and Coal Washing.

Preparation required: Ore. 1 to 9, 13 to 21, 31 to 39.

Ore. 317, 318, 319, 320. Research Work in Education in Ore Dressing and Coal Washing.

Preparation required: Ore. 1 to 9, 13 to 21, 31 to 39.

See University Catalog Part IX.

XII. PALEOBOTANY

UNDERGRADUATE WORK

MR. JENNINGS

F. Bot. 1, 2, 3. Paleobotany.

Preparation required: Entrance requirements in Botany.

Preceded by or taken with Geol. 6.

Fall, Winter, and Spring, or Summer Terms, 2 hours, 2 credits each.

F. Bot. 4, 5, 6. Paleobotany.

Preparation required: F. Bot. 1, 2, 3; Geol. 4 or 9.

Taken with Geol. 26, 27, 28.

Fall, Winter, and Spring, or Summer Terms, 2 hours, 2 credits each.

F. Bot. 7, 8, 9. Paleobotany.

Preparation required: F. Bot. 4, 5, 6.

Taken with Geol. 29, 30, 31.

Fall, Winter, and Spring, or Summer Terms, 2 hours, 2 credits each.

F. Bot. 10, 11, 12. Paleobotany.

Preparation required: F. Bot. 7, 8, 9.

Fall, Winter, and Spring, or Summer Terms, 2 hours, 2 credits each.

F. Bot. 13, 14, 15. Paleobotanical Laboratory.

Taken with F. Bot. 1, 2, 3.

Fall, Winter, and Spring, or Summer Terms, 6 to 60 hours, 2 to 20 credits each.

F. Bot. 16, 17, 18. Paleobotanical Laboratory.

Preparation required: F. Bot. 13, 14, 15.

Taken with F. Bot. 4, 5, 6.

Fall, Winter, and Spring, or Summer Terms, 6 to 60 hours, 2 to 20 credits each.

F. Bot. 19, 20, 21. Paleobotanical Laboratory.

Preparation required: F. Bot. 16, 17, 18.

Taken with F. Bot. 7, 8, 9.

Fall, Winter, and Spring, or Summer Terms, 6 to 60 hours, 2 to 20 credits each.

F. Bot. 22, 23, 24. Paleobotanical Laboratory.

Preparation required: F. Bot. 35.

Taken with F. Bot. 10, 11, 12.

Fall, Winter, and Spring, or Summer Terms, 6 to 60 hours, 2 to 20 credits each.

F. Bot. 25, 26, 27, 28. Practical Work in Paleobotany.

Preparation required: F. Bot. 1, 2, 3, 13, 14, 15.

13 weeks, 18 credits each.

F. Bot. 29, 30, 31. Paleobotanical Evolution.

Preparation required: F. Bot. 1, 2, 3 or Geol. 6.

Fall, Winter, and Spring, or Summer Terms, 2 hours, 2 credits each.

Evolution of Plants.—The object of this course is to present briefly and in logical sequence the subject of the evolution of the plant kingdom. The simplest forms will be studied, and from them, step by step, the appearance of new characters and the advances in development will be noted, the relative importance of the various steps in advancement will be considered, and special emphasis will be placed upon these advances characterizing the main line of evolution as shown in fossil plants leading to our more highly developed modern plants. All available sources of information and illustration will be

drawn upon for the best presentation of the subject, embracing both paleobotany and modern botany, and much attention will be paid to the application of the various theories and general principles of organic evolution to the facts at hand.

GRADUATE WORK

MR. JENNINGS

Each subject is given from 6 to 60 hours a week or from 2 to 20 credits a term, and can be taken for as few or many terms or years as desired.

F. Bot. 301, 302, 303, 304. Research Work in Paleobotany.

Preparation required: F. Bot. 1 to 24.

F. Bot. 305, 306, 307, 308. Research Work on the Paleozoic Flora.

Preparation required: F. Bot. 1 to 6, 13 to 18.

F. Bot. 309, 310, 311, 312. Research Work on the Mesozoic Flora.

Preparation required: F. Bot. 1 to 9, 13 to 21.

F. Bot. 313, 314, 315, 316. Research Work on the Cenozoic Flora.

Preparation required: F. Bot. 1 to 9, 13 to 21.

F. Bot. 317, 318, 319, 320. Research Work on Pennsylvania Paleobotany.

Preparation required: F. Bot. 1 to 9, 13 to 21.

F. Bot. 321, 322, 323, 324. Research Work on the Paleobotany of the United States.

Preparation required: F. Bot. 1 to 24.

F. Bot. 325, 326, 327, 328. Research Work upon the History of Paleobotany.

Preparation required: F. Bot. 1 to 24.

F. Bot. 329, 330, 331, 332. Research Work upon Paleobotanical Education.

Preparation required: F. Bot. 1 to 24.

F. Bot. 1 to 28 are intended for Graduates as well as Undergraduates.

See University Catalog Part IX.

XIII. PALEONTOLOGY

UNDERGRADUATE WORK

DR. EASTMAN AND MR. DOUGLASS

The object of these subjects is to familiarize the student in the field and laboratory with the more common fossils, particularly those that characterize the Paleozoic formations. Naturally, especial attention will be given to the Pennsylvania fauna. The student will be afforded prac-

tice in the determination of various types which he is expected to draw and describe.

The class room work, with the associated laboratory work, is arranged largely for its use in prospecting and mining in the coal and other stratified formations.

The courses in Paleontology will, as far as is practicable, be given at the Carnegie Museum, in order that the student may have ready access to its large collection of fossils. The laboratory work will be the most important part of these courses and the student will be expected to become familiar with the characteristic fossils of the various formations by the study of actual specimens.

The text books used will be *North American Index Fossils*, by Grabau and Shimer, and *Text-Book of Paleontology*, by Zittel-Eastman.

For students who are able to read scientific German, the treatise by Drs. Haas and Gürich, entitled *Leitfossilien*, will be found serviceable.

Special opportunities for research are offered by the constantly increasing collections of the Carnegie Museum.

Pal. 1, 2, 3. Invertebrate Paleontology.

Preparation required: Entrance requirements in Zoölogy.

Taken with Pal. 27, 28, 29. Preceded by or taken with Geol. 4 or 9, and 7.

Fall, Winter, and Spring, or Summer Terms, 2 hours, 2 credits each.

Courses 1, 2, 3, with Pal. 27, 28, 29, are intended to present a general survey of the field of Invertebrate Paleontology. The work will consist of one lecture, one recitation, and two laboratory periods per week. Beginning with the Protozoa each of the groups of invertebrate animals whose remains are preserved as fossils will be studied. These courses may be elected by any students of the University who wish an elementary knowledge of the subject.

Pal. 4, 5, 6. Invertebrate Paleontology.

Preparation required: Pal. 1, 2, 3, 27, 28, 29.

Taken with Pal. 30, 31, 32. Preceded by or taken with Geol. 26, 27, 28.

Fall, Winter, and Spring, or Summer Terms, 2 hours, 2 credits each.

These courses are designed to enable the student to determine formations by the aid of fossils. The characteristic fossils of the formations of the Paleozoic will be studied.

Pal. 7, 8, 9. Invertebrate Paleontology.

Preparation required: Pal. 4, 5, 6.

Taken with Pal. 33, 34, 35; Preceded by or taken with Geol. 29, 30, 31.

Fall, Winter, and Spring, or Summer Terms, 2 hours, 2 credits each.

These courses are a continuation of Pal. 4, 5, 6. The characteristic fossils of the formations of the Mesozoic and Cenozoic will be studied.

Pal. 10, 11, 12. Invertebrate Paleontology.

Preparation required: Pal. 7, 8, 9.

Taken with Pal. 36, 37, 38.

Fall, Winter, and Spring, or Summer Terms, 2 hours, 2 credits each.

Pal. 13. Invertebrate Paleontology.

Summer Term, 3 hours, 3 credits.

A brief course of lectures and demonstrations, adapted to the needs of teachers of Biology and General Geology. It will not be accepted as preparation for advanced courses in Paleontology.

Pal. 14. Invertebrate Paleontology.

Taken with Pal. 13.

Summer Term, 3 hours, 3 credits.

A brief course of lectures and demonstrations on the characteristic fossils of the principal stratigraphic divisions. Adapted to the needs of teachers of Historical Geology. Can not be used as preparation for advanced courses.

Pal. 15, 16, 17. Vertebrate Paleontology.

Preparation required: Entrance requirements in Zoölogy; Preceded by or taken with Geol. 4 or 9, and 7;

Taken with Pal. 39, 40, 41.

Fall, Winter, and Spring, or Summer Terms, 2 hours, 2 credits each.

Pal. 15, 16, 17 are elementary courses in Vertebrate Paleontology.

Pal. 18, 19, 20. Vertebrate Paleontology.

Preparation required: Pal. 15, 16, 17. Taken with or preceded by Geol. 26, 27, 28.

Taken with Pal. 39, 40, 41.

Fall, Winter, and Spring, or Summer Terms, 2 hours, 2 credits each.

In courses Pal. 18, 19, 20 the vertebrate fossils characteristic of the formations of the Paleozoic and Mesozoic will be studied.

Pal. 21, 22, 23. Vertebrate Paleontology.

Preparation required: Pal. 18, 19, 20. Preceded by or taken with Geol. 29, 30, 31.

Taken with Pal. 45, 46, 47.

Fall, Winter, and Spring, or Summer Terms, 2 hours, 2 credits each.

These courses will take up the vertebrate fossils characteristic of the formations of the Cenozoic.

Pal. 24, 25, 26. Vertebrate Paleontology.

Preparation required: Pal. 21, 22, 23.

Taken with Pal. 48, 49, 50.

Fall, Winter, and Spring, or Summer Terms, 2 hours, 2 credits each.

Pal. 27, 28, 29. Paleontological Laboratory.

Must be taken with Pal. 1, 2, 3.

Fall, Winter, and Spring, or Summer Terms, 6 hours, 2 credits each.

The student will be expected to become familiar with typical fossils of each group of the Invertebrata, their mode of occurrence, and methods of preservation.

Pal. 30, 31, 32. Paleontological Laboratory.

Must be taken with Pal. 4, 5, 6.

Fall, Winter, and Spring, or Summer Terms, 6 hours, 2 credits each.

In this course the actual specimens of the characteristic invertebrate fossils of the formations of the Paleozoic will be studied, drawn, described, and systematically identified. Excursions will be taken to collect fossils in the vicinity of Pittsburgh.

Pal. 33, 34, 35. Paleontological Laboratory.

Preparation required: Pal. 30, 31, 32.

Taken with Pal. 7, 8, 9.

Fall, Winter, and Spring, or Summer Terms, 6 hours, 2 credits each.

This course is similar to Pal. 30, 31, 32 except that the invertebrate fossils studied will be those characteristic of the Mesozoic and Cenozoic.

Pal. 36, 37, 38. Paleontological Laboratory.

Preparation required: Pal. 33, 34, 35.

Taken with Pal. 10, 11, 12.

Fall, Winter, and Spring, or Summer Terms, 6 hours, 2 credits each.

Pal. 39, 40, 41. Paleontological Laboratory.

Taken with Pal. 15, 16, 17.

Fall, Winter, and Spring, or Summer Terms, 6 hours, 2 credits each.

Laboratory study of Vertebrate Paleontology.

Pal. 42, 43, 44. Paleontology Laboratory.

Preparation required: Pal. 39, 40, 41.

Taken with Pal. 18, 19, 20.

Fall, Winter, and Spring, or Summer Terms, 6 hours, 2 credits each.

A study of specimens illustrating the vertebrate fossils of the Paleozoic and the Mesozoic.

Pal. 45, 46, 47. Paleontological Laboratory.

Preparation required: Pal. 42, 43, 44.

Taken with Pal. 21, 22, 23.

Fall, Winter, and Spring, or Summer Terms, 6 hours, 2 credits each.

Pal. 45, 46, 47 take up the study of the Vertebrates characteristic of the Cenozoic.

Pal. 48, 49 50. Paleontological Laboratory.

Preparation required: Pal. 45, 46, 47.

Taken with Pal. 24, 25, 26.

Fall, Winter, and Spring, or Summer Terms, 6 hours, 2 credits each.

Each of the courses given below can be taken from 3 to 60 hours a week with from 1 to 20 credits a term. They are intended only for those students who desire to prepare themselves to take up research work in Invertebrate or Vertebrate Paleontology. They are arranged in connection with the preceding work so that the study can be carried on along either of these two lines. The aim will be to work through the principal groups of fossils, learning the methods of collecting, preparing, and

studying fossils, and becoming familiar with the technicalities of each group. As a matter of convenience the work is registered in different terms and years, but will be varied to suit the needs of the different paleontological students. The courses are conducted through the Fall, Winter, and Spring, or Summer Terms as may be desired.

Pal. 51, 52, 53. Paleontological Laboratory.

Taken with Pal. 27, 28, 29.

Pal. 54, 55, 56. Paleontological Laboratory.

Taken with Pal. 30, 31, 32.

Pal. 57, 58, 59. Paleontological Laboratory.

Taken with Pal. 33, 34, 35.

Pal. 60, 61, 62. Paleontological Laboratory.

Taken with Pal. 36, 37, 38.

Pal. 63, 64, 65. Paleontological Laboratory.

Taken with Pal. 39, 40, 41.

Pal. 66, 67, 68. Paleontological Laboratory.

Taken with Pal. 42, 43, 44.

Pal. 69, 70, 71. Paleontological Laboratory.

Taken with Pal. 45, 46, 47.

Pal. 72, 73, 74. Paleontological Laboratory.

Taken with Pal. 48, 49, 50.

Pal. 75, 76, 77. Paleontological Evolution.

Preparation required: Pal. 1, 2, 3, 15, 16, 17 or Geol. 7.

It will be shown in this course that the Darwinian theory of descent affords a reasonable interpretation of the phenomena of the succession of life as shown in the rocks. In a brief way the history and relationship of each of the divisions of the animal kingdom will be traced from its first appearance in the geological series, through each successive stage, until its extinction or persistence into the modern fauna, with a view toward illustrating the different grades in the course of its development.

At the outset will be considered the nature of the evidence to be derived from paleontology, and its application to the general theory of descent. In contrast to the study of living organisms, in which every structural detail can be determined, only the hard parts of fossils have been preserved, and these often in scattered fragments, with their original condition modified in varying degrees by fossilization, so that satisfactory conclusions as to the characters of fossil organisms can only be made by those investigators who, in addition to a thorough knowledge of the anatomy and development of living animals, have acquired experience in interpreting the relations of mere fragments, and these often masked and distorted. Throughout the course, emphasis will be placed upon the facts and conclusions derived from paleontological science, rather than from the standpoint of modern Zoölogy.

GRADUATE WORK

DR. EASTMAN AND MR. DOUGLASS

All the courses given below are taken from 6 to 60 hours a week, from 1, or 2, or 3, or 4 terms a year, giving 2 to 20 credits each term of the year, and for as many years as desired.

Pal. 301, 302, 303, 304. Research Work in Invertebrate Paleontology.

Preparation required: Pal. 1-12, 27-38.

Pal. 305, 306, 307, 308. Research Work in Vertebrate Paleontology.

Preparation required: Pal. 15-26, 39-50.

Pal. 309, 310, 311, 312. Research Work on the Paleontology of Pennsylvania.

Preparation required: Pal. 1-6, 15-20.

Pal. 313, 314, 315, 316. Research Work on the Paleontology of the United States.

Preparation required: Pal. 1-6, 15-20.

Pal. 317, 318, 319, 320. Research Work on the Paleozoic Fauna.

Preparation required: Pal. 1-6, 15-20.

Pal. 321, 322, 323, 324. Research Work on the Mesozoic Fauna.

Preparation required: Pal. 7-9, 33-35.

Pal. 325, 326, 327, 328. Research Work on the Cenozoic Fauna.

Preparation required: Pal. 7-9, 33-35.

Pal. 1-6, 12-14, 18-32 are intended for Graduates as well as for Undergraduates.

See Part IX. University catalog.

XIV. PETROGRAPHY

UNDERGRADUATE WORK

DEAN WADSWORTH AND MESSRS. EATON AND LEIGHTON

This group is considered here under two heads: (1) Optical and Microscopical Mineralogy and (2) Microscopical Petrography.

Pet. 1, 2, 3. Optical and Microscopical Mineralogy.

Preparation required: Min. 3, 4, 5; Geol. 3, 4; M. Geol. 1.

Taken with Pet. 10, 11, 12.

Fall, Winter, and Spring, or Summer Terms, 2 hours, 2 credits each.

MESSRS. EATON AND LEIGHTON

OPTICAL AND MICROSCOPICAL MINERALOGY—Under this head are treated the various optical and other characteristics of minerals as revealed by the microscope. Alterations of minerals are especially studied, owing to their importance in the subjects of Mining Geology and Petrography. The lectures given are chiefly devoted to the description and use of the microscope as a simple instrument and as a piece of optical apparatus for the determination of minerals and rocks.

This part of the work will comprise the use of the petrographical microscope in common and polarized light, both as a microscope and as a polariscope; the chemical properties of minerals as determined under the microscope; and the distinguishing characters of important rock-forming minerals and their alterations.

These lectures are intended to give a clear and suitable introduction to the subject of Microscopical and Optical Mineralogy, which shall be adapted to the needs of geologists, civil and mining engineers, chemists, metallurgists, teachers, architects, and others who need a good working or practical knowledge of the subject.

Pet. 4, 5, 6. Microscopical Petrography.

Preparation required: Pet. 1 2, 3, 10, 11, 12.

Taken with Pet. 13, 14, 15.

Fall, Winter, and Spring, or Summer Terms, 2 hours, 2 credits each.

DEAN WADSWORTH AND MR. EATON

Pet. 7, 8, 9. Microscopical Petrography, continued.

Preparation required: Pet. 4, 5, 6, 13, 14, 15.

Taken with Pet. 16, 17, 18.

Fall, Winter, and Spring, or Summer Terms, 2 hours, 2 credits each.

DEAN WADSWORTH AND MR. EATON

MICROSCOPICAL PETROGRAPHY—Under this head instruction is given by means of lectures and laboratory practice upon the microscopical characters of rocks as revealed in their thin sections. It is based on the earlier instruction in Microscopical Petrography and the preceding Optical and Microscopical Mineralogy. It is intended not only to assist the student to name the rocks and to learn their origin, characters, mode of occurrence, and associations, but also to enable him to understand better the alteration or metamorphism of rocks and the origin and structure of ores and other useful mineral deposits.

Pet. 10, 11, 12. Petrographical Laboratory.

Preparation required: Min. 3, 4, 5; Geol. 3, 5; M. Geol. 1.

Taken with Pet. 1, 2, 3.

Fall, Winter, and Spring, or Summer Terms, 6 hours, 2 credits each.

MESSRS. EATON AND LEIGHTON

Pet. 13, 14, 15. Petrographical Laboratory, continued.

Preparation required: Pet. 1, 2, 3, 10, 11, 12.

Taken with Pet. 4, 5, 6.

Fall, Winter, and Spring, or Summer Terms, 6 hours, 2 credits each.

DEAN WADSWORTH AND MR. EATON

Pet. 16, 17, 18. Petrographical Laboratory, continued.

Preparation required: Pet. 4, 5, 6, 13, 14, 15.

Taken with Pet. 7, 8, 9.

Fall, Winter, and Spring, or Summer Terms, 6 hours, 2 credits each.

DEAN WADSWORTH AND MR. EATON

Pet. 19, 20, 21. Petrographical Laboratory.

Taken with Pet. 10, 11, 12.

Fall, Winter, and Spring, or Summer Terms, 3 to 54 hours, 1 to 18 credits each.

MESSRS. EATON AND LEIGHTON

Pet. 22, 23, 24. Petrographical Laboratory.

Taken with Pet. 13, 14, 15.

Fall, Winter, and Spring, or Summer Terms, 3 to 54 hours, 1 to 18 credits each.

DEAN WADSWORTH AND MR. EATON

Pet. 25, 26, 27. Petrographical Laboratory.

Taken with Pet. 16, 17, 18.

Fall, Winter, and Spring, or Summer Terms, 3 to 54 hours, 1 to 18 credits each.

DEAN WADSWORTH AND MR. EATON

Pet. 28, 29, 30, 31. Practical Work in Petrography.

Preparation required: Pet. 1, 2, 3, 10, 11, 12.

13 weeks, 1 to 18 credits each.

Pet. 32, 33, 34, 35. Microscopical Petrography.

Fall, Winter, Spring, and Summer Terms, Saturday, 1:30 to 4:30 P. M., 3 hours, 1 credit.

MESSRS. EATON AND LEIGHTON

GRADUATE WORK

DEAN WADSWORTH AND MR. EATON

Each subject is given from 3 to 60 hours a week, from 1 to 4 terms a year, and from 1 to 20 credits a term, for 1 or more years.

Pet. 301, 302, 303, 304. Research Work in Optical and Microscopical Mineralogy.

Preparation required: Pet. 1, 2, 3, 10, 11, 12.

Pet. 305, 306, 307, 308. Research Work in Microscopical Petrography.

Preparation required: Pet. 4 to 9, 13 to 18.

Pet. 309, 310, 311, 312. Research Work upon the Petrography of the Coal Measures.

Preparation required: Pet. 1 to 18.

Pet. 313, 314, 315, 316. Research Work upon the Petrography of Pennsylvania.

Preparation required: Pet. 1 to 18.

Pet. 317, 318, 319, 320. Research Work upon the Petrography of the United States.

Preparation required: Pet. 1 to 18.

Pet. 321, 322, 323, 324. Research Work in the History of Petrography.

Preparation required: Pet. 1 to 18.

Pet. 325, 326, 327, 328. Research Work in Petrographical Education.

Preparation required: Pet. 1 to 18.

Pet. 1 to 31 are intended for Graduates as well as Undergraduates.

See Part IX. University catalog.

ADVISORY COURSES.

The scheduled courses given below are only a few of the numerous good ones that can be arranged. They are not required to be followed, but are simply given to assist the student in wisely selecting his studies in sequence. Naturally they vary according to the instructor who formulated the group in his field. They are believed to be satisfactory schedules for any one to follow who wishes to obtain the desired result; but each student is encouraged to study out for himself that combination of subjects that will make the best schedule for a man of his temperament and capability. Such a study is, in itself, of great value to the student, and it certainly promotes self analysis and the use of knowledge, reason, and judgment.

As the School is in operation four terms a year, and the student required to attend only three terms, the terms he is present depends upon his choice. All the terms vary to a greater or less extent but in a general way the fall and summer terms are the nearest alike and may be more readily substituted one for the other. Again, Practical or Co-operative Work can replace one or more of the terms as the case may be.

MINING

In offering the following Advisory Courses in Mining, the endeavor has been to provide for the following classes of men:

1st.—For the one who wishes a broad, general training in mining engineering, not caring to specialize particularly upon either the coal or metal mining side.

2nd.—For the one who intends to specialize in Coal Mining.

3rd.—For the one who intends to follow Metal Mining;

These courses all lead to the degree of Engineer of Mines.

4th.—For the one who wants to prepare himself for work along the business or executive side of mining, taking more economics, mining law, etc., and less mathematics and engineering than those in the first class;

5th.—Similar in a general way to the fourth class, but admitting of specialization along the line of coal mining; and

6th.—A similar course for the one desiring to specialize in metal mining;

These last three courses lead to the degree of Bachelor of Science in Mining.

Two general outlines have been prepared, one of a course leading to the Engineer of Mines degree and the other of a course leading to the

Bachelor of Science degree. In each case there have been placed, first, those subjects, which, in our judgment, all students intending to take that degree should elect. Below under "Selectives" are listed a number of courses from which the student may choose a sufficient number to complete his schedule. This plan allows the specialization mentioned above.

ADVISORY COURSE FOR THE DEGREE OF ENGINEER OF MINES

FIRST YEAR

Fall or Summer Term

No.	Subject	Class	Lab.	Credits
Mat. 2.	Advanced Algebra	5	0	5
Ch. 1.	General Inorganic Chemistry	2	6	4
Dr. 1.	Mechanical Drawing	0	3	1
P. Mec. 1.	Frame Work and Pattern Making	1	6	3
En. 1.	English	3	0	3
Geol. 3.	General Geology	3	0	3
Min. 3.	Crystallography and Mineralogy	2	12	6
		16	27	25

Winter Term

Mat. 7.	Analytic Geometry	2	0	2
Ch. 2.	General Inorganic Chemistry	2	6	4
Dr. 2.	Mechanical Drawing	0	3	1
P. Mec. 2.	Foundry Work	1	6	3
En. 2.	English	3	0	3
Geol. 4.	Stratigraphical Geology	3	0	3
Min. 4.	Mineralogy	2	12	6
		13	27	22

Spring Term

Mat. 6.	Spherical Trigonometry	2	0	2
Mat. 8.	Analytic Geometry	3	0	3
Ch. 8.	Qualitative Analysis	2	6	4
Dr. 3.	Mechanical Drawing	0	6	2
P. Mec. 3.	Forge Work	1	6	3
M. Geol. 1.	Mining Geology	3	0	3
Min. 5.	Mineralogy and Lithology	2	12	6
		13	30	23

Summer Term

M. Sur. 11.	Mining Surveying	50 hours per week, 23 credits
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SECOND YEAR

Fall or Summer Term

No.	Subject	Class	Lab.	Credits
Mat. 9.	Calculus	4	0	4
Ch. 9.	Quantitative Analysis	1	6	3
Dr. 4.	Mechanical Sketching and Drafting	0	6	2
P. Mec. 4.	Machine Work in Metals	1	3	2
Phy. 11.	General Physics	4	3	5
Geol. 5.	Structural and Field Geology	3	0	3
Mine. 1.	Elements of Mining	3	0	3

Selectives

Geol. 48.	Field Geology	0	6	2
M. Sur. 1.	Inspection Trips	0		2

Winter Term

Mat. 10.	Calculus	4	0	4
Ch. 10.	Quantitative Analysis	1	6	3
Dr. 5.	Descriptive Geometry	2	6	4
P. Mec. 5.	Machine Work in Metals	1	3	2
Phy. 12.	General Physics	4	3	5
Mine 13.	Prospecting and Boring	2	0	2
Mine 14.	Shaft Sinking	2	0	2

Selectives

Mine 2.	Coal Mining Methods	2	0	2
Mine 49.	Inspection Trips or Mining Laboratory	0	6	2
Geol. 49.	Geological Mapping	0	6	2

Spring Term

Ch. 11.	Quantitative Analysis	1	0	3
Mec. 1.	Analytic Mechanics	5	0	5
Phy. 13.	General Physics	4	3	5
Mine 16.	Supporting Excavations	2	0	2
Mine 17.	Engines and Boilers	2	3	3

Selectives

Mine 3.	Coal Mining	2	0	2
Mine 11.	Ore Mining Methods	2	0	2
Mine 50.	Inspection Trips or Mining Laboratory	0	6	2
Geol. 16.	Chemical and Physical Geology— Review	3	0	3
Geol. 50.	Field Geology	0	6	2

THIRD YEAR

Fall or Summer Term

No.	Subject	Class	Lab.	Credits
Mec. 2.	Mechanics of Materials	5	0	5
Mec. 3.	Mechanical Laboratory	0	6	2
Mec. 4.	Graphic Statics	1	6	3
E. E.	Applied Electricity	2	3	3
Ore 1.	Ore Dressing	3	0	3
Mine 18.	Power Generation and Transmission	2	0	2
Mine 21.	Haulage	2	0	2
Mine 22.	Hoisting	2	0	2

Selectives

Met. 74.	Fire Assaying	1	6	3
Met. 1.	Calorimetry, Pyrometry, Fuels, etc.	3	0	3
Met. 3.	Furnaces and Refractories	2	0	2

Winter Term

Mec. 5.	Hydro-Mechanics and Hydraulics	4	0	4
Mec. 6.	Hydraulic Laboratory	0	3	1
Ore. 2.	Ore-Dressing and Coal-Washing	3	0	3
Mine 7.	Mine Gases	3	0	3
Mine 19.	Compressed Air in Mining	2	0	2
Mine 23.	Drainage	2	0	2
Mine 24.	Pumps and Pumping Machinery	2	0	2
Met. 4.	Furnaces and Refractories	2	0	2
Met. 43.	Metallurgical Laboratories	0	6	2
Met. 75.	Fire Assaying	1	6	3
Ore 13.	Ore-Dressing Laboratory	0	6	2
Ore 31.	Coal-Washing Laboratory	0	6	2
Mine 4.	Coal-Mining Machinery	2	3	3
Mine 34.	Placer and Hydraulic Mining and Dredging	2	0	2

Spring Term

Mine 25.	Explosives—their care and use (First half)	4	0	2
Mine 9.	Ventilation (First half)	4	0	2
Mine 20.	Electricity Applied to Mining (First half)	4	6	3

Selectives

Mine 15.	Rock Drills (First half)	4	0	2
Mine 54.	Mining Lab.—use of rock drills (First half)	0	6	1
Mine 26.	First Aid to the Injured (First half)	2	3	1½
Mine 29.	Mine Rescue Training	0	6	1
Mine 27.	First Aid (continued) (Second half)	2	3	1½

No.	Subject	Class	Lab.	Credits
Mine 30.	Mine Rescue Training (continued) (Second half)	0	6	1
Mine 10.	Design of Ventilating Machinery (Second half)	2	12	3
	Mine Excursions (Second half)	6	weeks	12
Mine 8.	Mine Gas Analysis (Entire Term)	1	6	3
Mine 5.	Coal Mining Machinery (Entire Term)	2	3	3

FOURTH YEAR

Fall or Summer Term

No.	Subject	Class	Lab.	Credits
Mine 42.	Engineering Design	1	6	3
M. Ec. 1.	Mine Economics	2	0	2
M. Ec. 4.	Mine Management	2	0	2
Law. 1.	Principles of Law and Mining Law	2	0	2
Mine 73.	Seminar	2	0	2

Selectives

Pet. 1.	Petrography	2	0	2
Pet. 10.	Petrographical Laboratory	0	6	2
M. Geol. 5.	Mineral Wealth of North America	2	0	2
M. Geol. 24.	Coal and Peat Deposits	2	0	2
Mine 37.	Development of Coal Properties	1	6	3
Mine 40.	Development of Metal Mines	1	6	3
Mine 45.	Mining Costs	3	0	3
Sp. 30.	Spanish	3	0	3

Winter Term

Mine 43.	Engineering Design	1	6	3
M. Ec. 2.	Mine Economics	2	0	2
M. Ec. 5.	Mine Management	2	0	2
Law. 2.	General Mining Law	2	0	2
Mine 74.	Seminar	2	0	2

Selectives

Pet. 2.	Petrography	2	0	2
Pet. 11.	Petrographical Laboratory	0	6	2
M. Geol. 6.	Mineral Wealth of North America	2	0	2
M. Geol. 14.	Clays	2	0	2
Mine 38.	Development of Coal Properties	1	6	3
Mine 41.	Development of Metal Mines	1	6	3
Mine 46.	Mining Costs	3	0	3
Mine 33.	Deep Mining	2	0	2
Sp. 31.	Spanish	3	0	3

Spring Term

No.	Subject	Class	Lab.	Credits
Mine 44.	Engineering Design	1	6	3
M. Ec. 3.	Principles of Mine Economics	2	0	2
M. Ec. 6.	Mine Management	2	0	2
Law 3.	General Mining Law	2	0	2
Law 3.	General Mining Law	2	0	2
Mine 75.	Seminar	2	0	2

Selectives

Pet. 3.	Petrography	2	0	2
Pet. 12.	Petrographical Laboratory	0	6	2
M. Geol. 7.	Mineral Wealth of North America	2	0	2
M. Geol. 27.	Petroleum and Natural Gas	2	0	2
Mine 47.	Mine Valuation	1	6	3
Sp. 32.	Spanish	3	0	3

ADVISORY COURSES FOR DEGREE OF BACHELOR OF SCIENCE IN MINING

FIRST YEAR

Fall or Summer Term

No.	Subject	Class	Lab.	Credits
Ch. 1.	General Inorganic Chemistry	2	6	4
Dr. 1.	Mechanical Drawing	0	3	1
P. Mec. 1.	Frame Work and Pattern Making	1	6	3
En. 1.	English	3	0	3
Geol. 3.	General Geology	3	0	3
Min. 3.	Crystallography and Mineralogy	2	12	6
		11	27	20

Winter Term

Ch. 2.	General Inorganic Chemistry	2	6	4
Dr. 2.	Mechanical Drawing	0	3	1
P. Mec. 2.	Foundry Work	1	6	3
Geol. 4.	Stratigraphical Geology	3	0	3
En. 2.	English	3	0	3
Min. 4.	Mineralogy and Lithology	2	12	6
		11	27	20

Spring Term

No.	Subject	Class	Lab.	Credits
Mat. 6.	Spherical Trigonometry	2	0	2
Ch. 8.	Qualitative Analysis	2	6	4
Dr. 3.	Mechanical Drawing	0	6	2
P. Mec. 3.	Forge Work	1	6	3
M. Geol. 1.	Mining Geology	3	0	3
En. 3.	English	3	0	3
Min. 5.	Mineralogy and Lithology	2	12	6
		13	30	23

Summer Term

M. Sur. 11.	Mining Surveying	50 hours per week	23
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SECOND YEAR

Fall or Summer Term

No.	Subject	Class	Lab.	Credits
Ch. 9.	Quantitative Analysis	1	6	3
Dr. 4.	Mechanical Sketching and Drafting	0	6	2
P. Mec. 4	Machine Work in Metals	1	3	2
Phy 1.	General Physics	3	3	4
Geol. 5.	Stratigraphical and Field Geology	3	0	3
Mine 1.	Elements of Mining	3	0	3

Selectives

En. 7.	English	3	0	3
Fr. 1 or 4.	French	3	0	3
Ger. 1 or 4.	German	3	0	3
Ec. 47.	Accounting	1	3	2
Geol. 48.	Field Geology	0	6	2
M. Sur. 1.	Inspection Trips	0	6	2

Winter Term

Ch. 10.	Quantitative Analysis	1	6	3
P. Mec. 5.	Machine Work in Metals	1	3	2
Phy. 2.	General Physics	3	3	4
Mine 13.	Prospecting and Boring	2	0	2
Mine 14.	Shaft Sinking	2	0	2

Selectives

En. 8.	English	3	0	3
Fr. 2. or 5.	French	3	0	3
Ger. 2.	German	3	0	3
Ec. 48.	Accounting	1	3	2
Mine 2.	Coal Mining Methods	2	0	2
Mine 49.	Inspection Trips or Mining Laboratory	0	6	2
Geol. 49.	Geological Mapping	0	6	2

Spring Term

No.	Subject	Class	Lab.	Credits
Ch. 11.	Quantitative Analysis	1	6	3
Phy. 3.	General Physics	3	3	4
Mine 16.	Supporting Excavations	2	0	2
Mine 17.	Engines and Boilers	2	3	3

Selectives

En. 16.	English	3	0	3
Fr. 3 or 6.	French	3	0	3
Ger. 3 or 6.	German	3	0	3
Ec. 49.	Accounting	1	3	2
Mine 3.	Coal Mining	2	0	2
Mine 11.	Ore Mining Methods	2	0	2
Mine 50.	Inspection Trips or Mining Laboratory	0	6	2
Geol. 16.	Physical and Chemical Geology— (Review)	3	0	3
Geol. 50.	Field Geology	0	6	2

THIRD YEAR

Fall or Summer Term

No.	Subject	Class	Lab.	Credits
Phy. 4.	Physics Laboratory	0	9	3
Ore 1.	Ore Dressing	3	0	3
Mine 18.	Power Generation and Transmission	2	0	2
Mine 21.	Haulage	2	0	2
Mine 22.	Hoisting	2	0	2
M. Ec. 1.	Mine Economics	2	0	2
Law 1.	Principles of Law and Mining Law	2	0	2

Selectives

Met. 1.	Calorimetry, Pyrometry, Fuels, etc.	3	0	3
Met. 43.	Metallurgical Laboratory	0	6	2
Met. 74.	Fire Assaying	1	6	3
Fr. 7.	French (Commercial)	3	0	3
Ger. 7.	German (Commercial)	3	0	3

Winter Term

Ore 2.	Ore-Dressing and Coal-Washing	3	0	3
Phy. 5.	Physics Laboratory	0	9	3
Mine 7.	Mine Gases	2	0	2
Mine 24.	Pumps and Pumping Machinery	2	0	2
M. Ec. 2.	Mine Economics	2	0	2
Law. 2.	General Mining Law	2	0	2

Selectives

No.	Subject	Class	Lab.	Credits
Met. 4.	General Metallurgy	2	0	2
Met. 75.	Fire Assaying	1	6	2
Ore 13.	Ore Dressing Laboratory	0	6	2
Ore 31.	Coal-Washing	0	6	2
Mine 4.	Coal Mining Machinery	2	3	3
Fr. 8.	French (Commercial)	3	0	3
Ger. 8.	German (Commercial)	3	0	3

Spring Term

Mine 25.	Explosives—Their care and use (First half)	4	0	2
Mine 9.	Ventilation (First half)	4	0	2
M. Ec. 3.	Mine Economics (First half)	2	0	1
Law 3.	General Mining Law (First half)	2	0	1

Selectives

Mine 15.	Rock Drills (First half)	4	0	2
Mine 54.	Mining Laboratory—use of rock drills (First half)	0	6	1
Mine 26.	First Aid to the Injured (First half)	2	3	1
Mine 29.	Mine Rescue Training (First half)	0	6	1
Mine 27.	First Aid to the Injured (continued) (Second half)	2	3	1
Mine 30.	Mine Rescue Training (continued) (Second half)	0	6	1
M. Ec. 3.	Principles of Mine Economics (continued) (Second half)	2	0	1
Law 3.	General Mining Law (continued) (Second half)	2	0	1
Mine 72.	Mine Excursions	6 weeks		12
Mine 8.	Mine Gas Analysis (Entire Term)	1	6	3
Fr. 8.	French (Commercial) (Entire Term)	3	0	3
Ger. 8.	German (Commercial) (Entire Term)	3	0	3
Mine 58.	Coal Mining Laboratory (Entire Term)	0	6	2

FOURTH YEAR

Fall or Summer Term

No.	Subject	Class	Lab.	Credits
M. Ec. 4.	Mine Management	2	0	2
M. Ec. 7.	Mining Corporations and Finance	2	0	2
Law 4.	Mining Contracts and Specifications	2	0	2
Ec. 43.	Business Law	2	0	2
Mine 73.	Seminar	2	0	2

Selectives

No.	Subject	Class	Lab.	Credits
Pet. 1.	Petrography	2	0	2
Pet. 10.	Petrographical Laboratory	2	0	2
M. Geol. 5.	Mineral Wealth of North America	2	0	2
M. Geol. 24.	Coal and Peat Deposits	2	0	2
Mine 37.	Development of Properties	1	6	3
Mine 40.	Development of Metal Mines	1	6	3
Mine 45.	Mining Costs	3	0	3
Law 7.	Advanced Mining Law	2	0	2
Sp. 30.	Spanish	3	0	3

Winter Term

M. Ec. 5.	Mine Management	2	0	2
M. Ec. 8.	Mining Corporations and Finance	2	0	2
Law 5.	Mining Contracts and Specifications	2	0	2
Ec. 44.	Business Law	2	0	2
Mine 74.	Seminar	2	0	2

Selectives

Pet. 2.	Petrography	2	0	2
M. Geol. 6.	Petrographical Laboratory	0	6	2
M. Geol. 6.	Mineral Wealth of North America	2	0	2
M. Geol. 14.	Clay Deposits	2	0	2
Mine 38.	Development of Coal Properties	1	6	3
Mine 41.	Development of Metal Mines	1	6	3
Mine 46.	Mining Costs	3	0	3
Law 8.	Advanced Mining Law	2	0	2
Sp. 31.	Spanish	3	0	3

Spring Term

M. Ec. 6.	Mine Management	2	0	2
M. Ec. 9.	Mining Corporation and Finance	2	0	2
Law 6.	Mining Contracts and Specifications	2	0	2
Ec. 45.	Business Law	2	0	2
Mine 75.	Seminar	2	0	2

Selectives

Pet. 3.	Petrography	2	0	2
Pet. 12.	Petrographical Laboratory	0	6	2
M. Geol. 7.	Mineral Wealth of North America	2	0	2
M. Geol. 27.	Petroleum and Natural Gas	2	0	2
Mine 47.	Mine Valuation	2	0	2
Law 9.	Advanced Mining Law	2	0	2
Sp. 32.	Spanish	3	0	3

ADVISORY TWO YEARS SHORT COURSE IN MINING

FIRST YEAR

Fall or Summer Term

No.	Subject	Class	Lab.	Credits
Min. 3.	Crystallography and Mineralogy	2	12	6
Geol. 3.	General Geology	3	0	3
Dr. 1.	Mechanical Drawing	0	3	1
Ch. 1.	General Inorganic Chemistry	2	6	4
Mine 1.	Elements of Mining	3	0	3

Selectives

M. Sur. 1.	Inspection trips	0	6	2
Geol. 48.	Field Geology	0	6	2
P. Mec. 1.	Frame Work	1	6	3

Winter Term

Min. 4.	Mineralogy	2	12	6
Geol. 4.	Stratigraphical Geology	3	0	3
Dr. 2.	Mechanical Drawing	0	3	1
Ch. 2-a.	General Inorganic Chemistry	2	6	4
Mine 13.	Prospecting and Boring	2	0	2
Mine 14.	Shaft Sinking	2	0	2

Selectives

P. Mec. 2.	Foundry Work	1	6	3
Mine 2.	Coal Mining Methods	2	0	2
Mine 49.	Inspection Trip or Mining Laboratory	0	6	2
Geol. 49.	Geological Mapping	0	6	2

Spring Term

Mat. 6.	Spherical Trigonometry	2	0	2
Min. 5.	Mineralogy and Lithology	2	12	6
M. Geol. 1.	Mining Geology	3	0	3
Dr. 3.	Mechanical Drawing	0	6	2
Ch. 8.	Qualitative Analysis	2	6	4
Mine 16.	Supporting Excavations	2	0	2
Mine 17.	Engines and Boilers	2	3	3

Selectives

P. Mec. 3.	Forge Work	1	6	3
Mine 3.	Coal Mining Methods	2	0	2
Mine 11.	Ore Mining Methods	2	0	2
Mine 50.	Inspection Trips or Mining Laboratory	0	6	2
Geol. 50.	Field Geology	0	6	2

Summer Term

M. Sur. 11.	Mining Surveying	50 hours per week, 23 credits		
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SECOND YEAR

Fall or Summer Term

No.	Subject	Class	Lab.	Credits
Geol. 5.	Stratigraphical and Field Geology	3	0	3
Ore. 1.	Ore Dressing	3	0	3
Mine 18.	Power Generation and Transmission	2	0	2
Mine 21.	Haulage	2	0	2
Mine 22.	Hoisting	2	0	2
Dr. 4.	Mechanical Sketching and Drafting	0	6	2
Phy. 1.	General Physics	3	3	4
M. Ec. 1.	Mine Economics	2	0	2
Law 1.	Principles of Law and Mining Law	2	0	2

Selectives

P. Mec. 4.	Machine Work in Metals	1	3	2
Met. 1.	Calorimetry, Pyrometry, Fuels, etc.	3	0	3
Met. 74.	Fire Assaying	1	6	3

Winter Term

Phy. 1.	General Physics	3	3	4
M. Ec. 2.	Mine Economics	2	0	2
Law. 2.	General Mining Law	2	0	2
Ore. 2.	Ore-Dressing and Coal-Washing	3	0	3
Mine 7.	Mine Gases	2	0	2
Mine 24.	Pumps and Pumping Machinery	2	0	2

Selectives

P. Mec. 5.	Machine Work in Metals	1	3	2
Met. 43.	Furnaces, Refractories, etc.	2	0	2
Met. 43.	Metallurgical Laboratory	0	6	2
Met. 75.	Fire Assaying	1	6	3
Ore 13.	Ore Dressing Laboratory	0	6	2
Ore 31.	Coal-Washing Laboratory	0	6	2
Mine 4.	Coal-Mining Machinery	2	3	3

Spring Term

Phy. 3.	General Physics (First half)	3	3	4
Mine 25.	Explosives—their care and use (First half)	4	0	2
Mine 9.	Ventilation (First half)	4	0	2
M. Ec. 3.	Mine Economics (First half)	2	0	2
Law. 3.	General Mining Law	2	0	2

Selectives

Mine 15.	Rock Drills (First half)	4	0	2
Mine 54.	Mining Laboratory—use of rock drills (First half)	0	6	1
Mine. 26, 27.	First Aid to the Injured (First half)	2	3	2
Mine 29, 30.	Mine Rescue Training (First half)	0	6	2
Mine 58.	Coal-Mining Laboratory (First half)	0	6	2

Special problems will be assigned, at the beginning of the Winter Term, to the individual students taking this two-year course, such problems to be worked out in mine and laboratory, and a complete report handed in before the end of the Spring Term. Time has been given in the above schedule for this work. Credits will be allowed according to the time necessary to be spent.

METALLURGY

ADVISORY COURSE FOR THE DEGREE OF METALLURGICAL ENGINEER

FIRST YEAR

For the First Year the Advisory Course for the Degree of Metallurgical Engineer is the same as that for the Engineer of Mines.

SECOND YEAR

Fall or Summer Term

No.	Subject	Class	Lab.	Credits
Mat. 9.	Calculus	4	0	4
Ch. 9.	Quantitative Analysis	1	6	3
Dr. 4.	Mechanical Sketching and Drafting	0	6	2
P. Mec. 4.	Machine Work in Metals	1	3	2
Phy. 11.	General Physics	4	3	5
Geol. 5.	Structural and Field Geology	3	0	3
Met. 2.	Calorimetry, Pyrometry, Fuels, etc.	2	0	2
Met. 43.	Metallurgical Laboratory	0	6	2
M. Geol. 5.	Mineral Wealth of North America	2	0	2
Ore. 1.	Ore Dressing and Coal Washing	3	0	3
		20	24	28

Winter Term

Mat. 10.	Calculus	4	0	4
Ch. 10.	Quantitative Analysis	1	6	3
Phy. 12.	General Physics	4	3	5
Dr. 5.	Descriptive Geometry	2	6	4
P. Mec. 5.	Machine Work in Metals	1	3	2
M. Geol. 6.	Mineral Wealth of North America	2	0	2
Met. 4.	Fuels and Furnaces	2	0	2
Met. 44.	Metallurgical Laboratory	0	6	2
Ore. 2.	Ore Dressing	3	0	3
		19	24	27

Spring Term

No.	Subject	Class	Lab.	Credits
Mec. 1.	Analytic Mechanics	5	0	5
Chem. 11.	Quantitative Analysis	1	6	3
Phy. 13.	General Physics	4	3	5
Geol. 16.	Physical and Chemical Geology	3	0	3
Geol. 50.	Field Geology	0	6	2
Met. 7.	Metallography	2	0	2
Met. 45.	Metallurgical Laboratory	0	6	2
M. Geol. 7.	Mineral Wealth of North America	2	0	2
Mine 17.	Engines and Boilers	2	3	3
		19	24	26

Summer Term

Practical (Co-operative) Work	13 weeks	18
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THIRD YEAR

Fall or Summer Term

No.	Subject	Class	Lab.	Credits
Mec. 2.	Mechanics of Materials	5	0	5
Mec. 3.	Mechanical Laboratory	0	6	2
Mec. 4.	Graphic Statics	1	6	3
Met. 10.	Metallurgical Calculations	3	0	3
Met. 73.	Fire Assaying	1	6	3

Selectives

Met. 16.	Metallurgy of Iron	2	0	2
Met. 23.	Metallurgy of Lead	2	0	2
Met. 46.	Metallurgical Laboratory	0	6	2
Met. 76.	Wet Assaying	0	6	2

Winter Term

Mec. 5.	Hydro-Mechanics and Hydraulics	4	0	4
Mec. 6.	Hydraulic Laboratory	0	3	1
Met. 11.	Metallurgical Calculations	3	0	3
Met. 25.	Metallurgy of Copper	2	0	2
E. E. 2.	Applied Electricity	2	3	3
Met. 74.	Fire Assaying	1	6	3

Selectives

Mine 2.	Coal Mining Methods	2	0	2
Met. 17.	Metallurgy of Iron	2	0	2
Met. 24.	Metallurgy of Lead	2	0	2
Met. 47.	Metallurgical Laboratory	0	6	2
Met. 77.	Wet Assaying	0	6	2

Spring Term

No.	Subject	Class	Lab.	Credits
M. E. 4.	Prime Movers	2	3	3
Met. 12.	Metallurgical Calculations	3	0	3
Met. 26.	Metallurgy of Copper	2	0	2
Met. 37.	Electro-Metallurgical Processes	2	0	2
Met. 40.	Metallurgical Designing	0	6	2
Mine 14.	Ore Mining Methods	3	0	3

Selectives

Met. 19.	Metallurgy of Steel	2	0	2
Met. 27.	Metallurgy of Zinc	2	0	2
Met. 48.	Metallurgical Laboratory	0	6	2
Met. 78.	Wet Assaying	0	6	2

FOURTH YEAR

Fall or Summer Term

No.	Subject	Class	Lab.	Credits
Met. 31.	Metallurgy of Gold, Silver, etc.	2	0	2
Met. 38.	Electro-Metallurgical Processes	2	0	2
Met. 41.	Metallurgical Designing	0	6	2
Met. 67.	Electro-Metallurgical Laboratory	0	6	2
Met. 104.	Metallurgical Excursions	2	6	4
M. Ec. 1.	Mining Economics	2	0	2
Law 1.	Principles of Law and Mining Law	2	0	2
Pet. 1.	Optical Mineralogy	2	0	2
Pet. 10.	Petrographical Laboratory	0	6	2

Selectives

Met. 20.	Metallurgy of Steel	2	0	2
Met. 28.	Metallurgy of Zinc	2	0	2

Winter Term

Met. 32.	Metallurgy of Gold, Silver, etc.	2	0	2
Met. 39.	Electro-Metallurgical Processes	2	0	2
Met. 42.	Metallurgical Design	0	6	2
Met. 68.	Electro-Metallurgical Laboratory	0	6	2
Met. 101.	Current Metallurgical Quantitative	0	6	2
Met. 105.	Metallurgical Excursions	2	6	4
M. Ec.	Mining Economics	2	0	2
Pet. 2.	Microscopical Mineralogy	2	0	2
Pet. 11.	Petrographical Laboratory	0	6	2

Selectives

Met. 21.	Metallurgy of Steel	2	0	2
Met. 29.	Metallurgy of Minor Metals	2	0	2

Spring Term

No.	Subject	Class	Lab.	Credits
Ec. 46.	Contracts, Specifications, etc.	3	0	3
Met. 33.	Metallurgy of Gold, Silver, etc.	2	0	2
Met. 102.	Current Literature	0	6	2
M. Ec. 3.	Mining Economic	2	0	2
Pet. 3.	Microscopical Mineralogy	2	0	2
Pet. 12.	Petrographical Laboratory	0	6	2
	Electives			10

ADVISORY COURSE FOR THE BACHELOR OF SCIENCE DEGREE IN METALLURGY

FIRST YEAR

Fall or Summer Term

No.	Subject	Class	Lab.	Credits
Ch. 1.	Inorganic Chemistry	2	6	4
Dr. 1.	Mechanical Drawing	0	3	1
P. Mec. 1.	Frame Work and Pattern Making	1	6	3
En. 1.	English	3	0	3
Geol. 3.	General Geology	3	0	3
Geol. 48.	Field Geology	0	6	2
Min. 3.	Crystallography and Mineralogy	2	12	6
		11	33	22

Winter Term

Ch. 2.	Inorganic Chemistry	2	6	4
Dr. 2.	Mechanical Drawing	0	3	1
P. Mec. 2.	Foundry	1	6	3
En. 2.	English	3	0	3
Geol. 4.	General Geology	3	0	3
Geol. 49.	Geological Mapping, etc.	0	6	2
Min. 4.	Mineralogy and Lithology	2	12	6
		11	33	22

Spring Term

Ch. 8.	Quantitative Analysis	2	6	4
Mat. 6.	Spherical Trigonometry	2	0	2
Dr. 3.	Mechanical Drawing	0	6	2
P. Mec. 3.	Forge Work	1	6	3
En. 3.	English	3	0	3
Geol. 50.	Field Geology	0	6	2
Min. 5.	Mineralogy and Lithology	2	12	6
M. Geol. 1.	Principles of Mining Geology	3	0	3
		13	36	25

Summer Term

M. Sur. 11.	Mining Surveying	50 hours	23 credits
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SECOND YEAR

Fall or Summer Term

No.	Subject	Class	Lab.	Credits
Ch. 9.	Quantitative Analysis	1	6	3
Phy. 1.	General Physics	3	3	4
Dr. 4.	Mechanical Sketching and Drawing	0	6	2
En. 7.	English	3	0	3
Geol. 8.	Structural and Field Geology	3	0	3
Met. 2.	Calorimetry, Pyrometry, Fuels, etc.	2	0	2
Met. 43.	Metallurgical Laboratory	0	6	2
M. Geol. 5.	Mineral Wealth of North America	2	0	2
Ore 1.	Ore Dressing and Coal Washing	3	0	3

Selectives

Fr. 1.	French	3	0	3
Ger. 1.	German	3	0	3

Winter Term

Ch. 10.	Quantitative Analysis	1	6	3
Phy. 2.	General Physics	3	3	4
Ec. 16.	Industrial Management	2	0	2
En. 8.	English	3	0	3
Met. 4.	Furnaces and Refractories	2	0	2
Met. 44.	Metallurgical Laboratory	0	6	2
M. Geol. 6.	Mineral Wealth of North America	2	0	2
Geol. 50.	Geological Sketching and Mapping	0	6	2
Ore. 2.	Ore Dressing	3	0	3

Selectives

Fr. 2.	German	3	0	3
Ger. 2.	French	3	0	3

Spring Term

Ch. 11.	Quantitative Analysis	1	6	3
Phy. 3.	General Physics	3	3	4
Ec. 46.	Contracts, Specifications, etc.	3	0	3
En. 16.	English	3	0	3
Geol. 51.	Field Geology	0	6	2
Met. 7.	Metallography	2	0	2
Met. 45.	Metallurgical Laboratory	0	6	2
M. Geol. 7.	Mineral Wealth of North America	2	0	2

Selectives

Fr. 3.	French	3	0	3
Ger. 3.	German	3	0	3

THIRD YEAR

Fall or Summer Term

No.	Subject	Class	Lab.	Credits
Phy. 4.	Physical Laboratory	0	9	3
Met. 10.	Metallurgical Calculations	3	0	3
Met. 16.	Metallurgy of Iron	2	0	2
Met. 23.	Metallurgy of Lead	2	0	2
Met. 73.	Fire Assaying	1	6	3
Mine 1.	Elements of Mining	3	0	3
M. Ec. 1.	Mining Economics	2	0	2

Selectives

Fr. 7.	Technical French	3	0	3
Ger. 7.	Commercial German	3	0	3
Met. 46.	Metallurgical Laboratory	0	6	2
Met. 79.	Wet Assaying	0	6	2

Winter Term

Phy. 5.	Physical Laboratory	0	9	3
Met. 11.	Metallurgical Calculations	3	0	3
Met. 17.	Metallurgy of Iron	2	0	2
Met. 24.	Metallurgy of Lead	2	0	2
Met. 25.	Metallurgy of Copper	2	0	2
Met. 74.	Fire Assaying	1	6	3
Mine 2.	Coal Mining Methods	2	0	2
M. Ec. 2.	Mining Economics	2	0	2

Selectives

Fr. 8.	Technical French	3	0	3
Gr. 8.	Commercial German	3	0	3
Met. 47.	Metallurgical Laboratory	0	6	2
Met. 80.	Wet Assaying	0	6	2

Spring Term

Phy. 6.	Physical Laboratory	0	9	3
Met. 12.	Metallurgical Calculations	3	0	3
Met. 19.	Metallurgy of Steel	2	0	2
Met. 26.	Metallurgy of Copper	2	0	2
Met. 37.	Electro-Metallurgical Processes	2	0	2
Met. 40.	Metallurgical Design	0	6	2
Mine 14.	Ore Mining Methods	3	0	3
M. Ec.	Mining Economics	2	0	2

Selectives

Fr. 9.	Technical French	3	0	3
Ger. 9.	Commercial German	3	0	3
Met. 48.	Metallurgical Laboratory	0	6	2
Met. 81.	Wet Assaying	0	6	2

FOURTH YEAR
Fall or Summer Term

No.	Subject	Class	Lab.	Credits
Ec. 47.	Accounting	2	0	2
Sp. 30.	Spanish	3	0	3
Met. 20.	Metallurgy of Steel	2	0	2
Met. 31.	Metallurgy of Gold, Silver, etc.	2	0	2
Met. 38.	Electro-Metallurgical Processes	2	0	2
Met. 41.	Metallurgical Design	2	6	4
Met. 67.	Electro-Metallurgical Laboratory	0	6	2
Met. 104.	Metallurgical Excursions	2	6	4
M. Ec. 7.	Mining Corporations and Finance	2	0	2

17 18 23

Winter Term

Ec. 48.	Accounting	2	0	2
Sp. 31.	Spanish	3	0	3
Met. 21.	Metallurgy of Steel	2	0	2
Met. 32.	Metallurgy of Gold, Silver, etc.	2	0	2
Met. 42.	Metallurgical Designing	2	6	4
Met. 68.	Electro-Metallurgical Laboratory	0	6	2
Met. 102.	Current Literature	0	6	2
Met. 105.	Metallurgical Excursions	2	6	4
M. Ec. 8.	Mining Corporation and Finance	2	0	2

15 24 23

Spring Term

Ec. 49.	Accounting	2	0	2
Sp. 32.	Spanish	3	0	3
Met. 30.	Metallurgy of the Minor Metals	2	0	2
Met. 103.	Current Literature	0	6	2
M. Ec. 9.	Mining Corporation and Finance	2	0	2
	Electives			12

ADVISORY TWO YEARS' COURSE IN FERROUS
METALLURGY.

FIRST YEAR
Fall or Summer Term

No.	Subject	Class	Lab.	Credits
Ch. 1.	Inorganic Chemistry	2	6	4
Dr. 1.	Mechanical Drawing	0	3	1
P. Mec. 1.	Frame Work and Pattern Making	1	6	3
Geol. 3.	General Geology	3	0	3
Met. 2.	Calorimetry, Pyrometry, Fuels, etc.	2	0	2
Met. 43.	Metallurgical Laboratory	0	6	2
Min. 3.	Crystallography and Mineralogy	2	12	6

10 33 21

Winter Term

No.	Subject	Class	Lab.	Credits
Ch. 2.	Inorganic Chemistry	2	6	4
Dr. 2.	Mechanical Drawing	0	3	1
P. Mec. 2.	Foundry	1	6	3
Geol. 4.	Stratigraphical Geology	3	0	3
Met. 4.	Furnaces and Refractory Materials	2	0	2
Met. 44.	Metallurgical Laboratory	0	6	2
Min. 4.	Mineralogy and Lithology	2	12	6
		10	33	21

Spring Term

Ch. 8.	Quantitative Analysis	2	6	4
Dr. 3.	Mechanical Drawing	0	6	2
P. Mec. 3.	Forge Work	1	6	3
Mat. 6.	Spherical Trigonometry	2	0	2
Sur. 1.	Surveying	2	3	3
Met. 7.	Metallography	2	0	2
Met. 45.	Metallurgical Laboratory	0	6	2
Min. 5.	Mineralogy and Lithology	2	12	6
M. Geol. 1.	Principles of Mining Geology	3	0	3
		14	39	27

Summer Term

Met. 120.	Metallography	60 hours.	23 credits.
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SECOND YEAR

Fall or Summer Term

No.	Subject	Class	Lab.	Credits
Ch. 9.	Quantitative Analysis	1	6	3
Dr. 4.	Mechanical Sketching and Drafting	0	6	2
Geol. 5.	Structural and Field Geology	3	0	3
Met. 10.	Metallurgical Calculations	3	0	3
Met. 16.	Metallurgy of Iron	2	0	2
Met. 37.	Electro-Metallurgical Processes	2	0	2
Met. 46.	Metallurgical Laboratory	0	6	2
Met. 73.	Fire Assaying	1	6	3
Met. 104.	Metallurgical Excursions	2	6	4
Ore. 1.	Ore Dressing	3	0	3
		17	30	27

Winter Term

No.	Subject	Class	Lab.	Credits
Ch. 10.	Quantitative Analysis	1	6	3
Met. 11.	Metallurgical Calculations	3	0	3
Met. 17.	Metallurgy of Iron	2	0	2
Met. 19.	Metallurgy of Steel	2	0	2
Met. 38.	Electro-Metallurgical Processes	2	0	2
Met. 67.	Electro-Metallurgical Laboratory	0	6	2
Met. 79.	Wet Assaying	0	6	2
Met. 105.	Metallurgical Excursions	2	6	4
Mine 1.	Elements of Mining	3	0	3
		15	24	26

Spring Term

Ch. 11.	Quantitative Analysis	1	6	3
Geol. 16.	Physical and Chemical Geology— Review	3	0	3
Geol. 50.	Field Geology	0	6	2
Met. 20.	Metallurgy of Steel	2	0	2
Met. 42.	Metallurgical Designing	2	6	4
Met. 48.	Metallurgical Laboratory	0	6	2
Met. 80.	Wet Assaying	0	6	2
Met. 103.	Current Literature	2	6	4
		10	36	22

ADVISORY SHORT COURSE IN NON-FERROUS METALLURGY

FIRST YEAR

Same as the first year in the Advisory Short Course in Ferrous Metallurgy, except the

Summer Term

Met. 121.	Metallurgical Laboratory	60 hours	23 credits.
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SECOND YEAR

Fall or Summer Term

No.	Subject	Class	Lab.	Credits
Ch. 9.	Quantitative Analysis	1	6	3
Dr. 4.	Mechanical Sketching and Drafting	0	6	2
Geol. 5.	Structural and Field Geology	3	0	3
Met. 10.	Metallurgical Calculations	3	0	3
Met. 23.	Metallurgy of Lead	2	0	2
Met. 37.	Electro-Metallurgical Processes	2	0	2
Met. 31.	Metallurgy of Gold, Silver, etc.	2	0	2
Met. 73.	Fire Assaying	1	6	3
Met. 104.	Metallurgical Excursions	2	6	4
Ore 1.	Ore Dressing	3	0	3
		16	24	24

Winter Term

No.	Subject	Class	Lab.	Credits
Ch. 10.	Quantitative Analysis	1	6	3
Met. 11.	Metallurgical Calculations	3	0	3
Met. 24.	Metallurgy of Lead	2	0	2
Met. 25.	Metallurgy of Copper	2	0	2
Met. 32.	Metallurgy of Gold, Silver, etc.	2	0	2
Met. 38.	Electro-Metallurgical Processes	2	0	2
Met. 67.	Electro-Metallurgical Laboratory	0	6	2
Met. 74.	Fire Assaying	1	6	3
Met. 79.	Wet Assaying	0	6	2
Mine 1.	Elements of Mining	3	0	3
Ore 2.	Ore Dressing	3	0	3
		19	18	25

Spring Term

Ch. 11.	Quantitative Analysis	1	6	3
Geol. 16.	Physical and Chemical Geology	3	0	3
Geol. 50.	Field Geology	0	6	2
Met. 12.	Metallurgical Calculations	3	0	3
Met. 26.	Metallurgy of Copper	2	0	2
Met. 33.	Metallurgy of Gold, Silver, etc.	2	0	2
Met. 42.	Metallurgical Design	2	6	4
Met. 48.	Metallurgical Laboratory	0	6	2
Met. 80.	Wet Assaying	0	6	2
Met. 103.	Current Literature	2	6	4
		15	36	27

ADVISORY SHORT COURSE IN ASSAYING

FIRST YEAR

Same as the first year in the Advisory Short Course in Non-Ferrous Metallurgy.

SECOND YEAR

Fall or Summer Term

No.	Subject	Class	Lab.	Credits
Ch. 3.	Advanced Inorganic Chemistry	2	0	2
Ch. 9.	Quantitative Analysis	1	6	3
Geol. 5.	Structural and Field Geology	3	0	3
Geol. 48.	Field Geology	0	6	2
Met. 23.	Metallurgy of Lead	2	0	2
Met. 31.	Metallurgy of Gold, Silver, etc.	2	0	2
Met. 46.	Metallurgical Laboratory	0	6	2
Met. 73.	Fire Assaying	1	6	3
Met. 79.	Wet Assaying	0	6	2
Ore 1.	Ore Dressing	3	0	3
		14	30	24

Winter Term

No.	Subject	Class	Lab.	Credits
Ch. 4.	Advanced Inorganic Chemistry	2	0	2
Ch. 10.	Quantitative Analysis	1	6	3
Geol. 49.	Geological Sketching and Mapping	0	6	2
Met. 24.	Metallurgy of Lead	2	0	2
Met. 25.	Metallurgy of Copper	2	0	2
Met. 32.	Metallurgy of Gold, Silver, etc.	2	0	2
Met. 47.	Metallurgical Laboratory	0	6	2
Met. 74.	Fire Assaying	1	6	3
Met. 80.	Wet Assaying	0	6	2
Mine 1.	Elements of Mining	3	0	3
Ore 2.	Ore Dressing	3	0	3
		13	30	25

Spring Term

Mat. 6.	Spherical Trigonometry	2	0	2
Ch. 5.	Advanced Inorganic Chemistry	2	0	2
Ch. 11.	Quantitative Analysis	1	6	3
Geol. 16.	Physical and Chemical Geology	3	0	3
Geol. 50.	Field Geology	0	6	2
Met. 26.	Metallurgy of Copper	2	0	2
Met. 33.	Metallurgy of Gold, Silver, etc.	2	0	2
Met. 48.	Metallurgical Laboratory	0	6	2
Met. 75.	Fire Assaying	1	6	3
Met. 81.	Wet Assaying	0	12	4
		12	36	25

MINING GEOLOGY

ADVISORY COURSE FOR DEGREE OF GEOLOGICAL ENGINEER

FIRST YEAR

Fall or Summer Term

No.	Subject	Class	Lab.	Credits
En. 1.	English	3	0	3
Mat. 2.	Advanced Algebra	5	0	5
Ch. 1.	Inorganic Chemistry	2	6	4
Dr. 1.	Mechanical Drawing	0	3	1
Geol. 3.	General Geology	3	0	3
Geol. 6.	Botanical Geology	3	0	3
Geol. 48.	Field Geology	0	6	2
Min. 3.	Crystallography and Mineralogy	2	12	6
		18	27	27

Winter Term

No.	Subject	Class	Lab.	Credits
En. 2.	English	3	0	3
Mat. 7.	Analytic Geometry	2	0	2
Ch. 2.	Inorganic Chemistry	2	6	4
Ast. 1.	General Astronomy	3	0	3
Dr. 2.	Mechanical Drawing	0	3	1
Geol. 4.	Stratigraphical Geology	3	0	3
Geol. 7.	Zoological Geology	3	0	3
Min. 4.	Mineralogy and Lithology	2	12	6
		18	21	25

Spring Term

En. 3.	English	3	0	3
Mat. 6.	Spherical Trigonometry	2	0	2
Mat. 8.	Analytic Geometry	3	0	3
Ch. 8.	Quantitative Analysis	2	6	4
Dr. 3.	Mechanical Drawing	0	6	2
Geol. 50.	Field Geology	0	6	2
Min. 5.	Mineralogy and Lithology	2	12	6
M. Geol. 1.	Principles of Mining Geology	3	0	3
		15	30	25

Summer Term

M. Sur. 11.	Mining Surveying	0	50	23
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SECOND YEAR

Fall or Summer Term

No.	Subject	Class	Lab.	Credits
Mat. 9.	Calculus	4	0	4
Ch. 9.	Quantitative Analysis	1	6	3
Dr. 4.	Mechanical Drawing	0	6	2
Phy. 11.	General Physics	4	3	5
Geol. 5.	Structural and Field Geology	3	0	3
Geol. 10.	Earth Origin and Structure	2	0	2
Mine 1.	Elements of Mining	3	0	3
M. Geol. 5.	Mineral Wealth of North America	2	0	2
Pet. 1.	Optical Mineralogy	2	0	2
Pet. 10.	Petrographical Laboratory	0	6	2
		21	21	28

Winter Term

No.	Subject	Class	Lab.	Credits
Mat. 9.	Calculus	4	0	4
Ch. 10.	Quantitative Analysis	1	6	3
Phy. 12.	General Physics	4	3	5
Geol. 11.	Vulcanism and Volcanoes	2	0	2
Met. 1.	Principles of Metallurgy	3	0	3
Met. 73.	Fire Assaying	1	6	3
M. Geol. 6.	Mineral Wealth of North America	2	0	2
Pet. 2.	Microscopical Mineralogy	2	0	2
Pet. 11.	Photographical Laboratory	0	6	2
		19	21	26

Spring Term

Mec. 1.	Analytic Mechanics	5	0	5
Ch. 11.	Quantitative Analysis	1	6	3
Phy. 13.	General Physics	4	3	5
Dr. 5.	Descriptive Geometry	2	6	4
Geol. 12.	Earthquakes and Earth Movements	2	0	2
Geol. 16.	Chemical and Physical Geology— Review	3	0	3
M. Geol. 7.	Mineral Wealth of North America	2	0	2
Pet. 3.	Microscopical Mineralogy	2	0	2
Pet. 12.	Petrographical Laboratory	0	6	2
		21	21	28

THIRD YEAR

Fall or Summer Term

No.	Subject	Class	Lab.	Credits
Mec. 2.	Mechanics of Materials	5	0	5
Mec. 3.	Mechanical Laboratory	0	6	2
Psy. 13.	General Psychology	3	0	3
Geol. 13.	Metamorphism: Mineral and Rock Alteration	2	0	2
M. Ec. 1.	Mining Economics	2	0	2
M. Geol. 8.	Metallites or Metalliferous Deposits	2	0	2
Law 1.	Principles of Law and Mining Law	2	0	2
Ore 1.	Ore Dressing and Coal Washing	3	0	3
Pet. 4.	Microscopical Petrography	2	0	2
Pet. 13.	Petrographical Laboratory	0	6	2
		23	12	27

Winter Term

No.	Subject	Class	Lab.	Credits
Mec. 5.	Hydro-Mechanics and Hydraulics	4	0	4
Mec. 6.	Hydraulic Laboratory	0	3	1
Ph. 1.	Ethics	3	0	3
Geol. 14.	Metamorphism: Mineral and Rock Alteration	2	0	2
Met. 83.	Wet Assaying	0	6	2
M. Ec. 2.	Mining Economics	2	0	2
M. Geol. 9.	Metallites or Metalliferous Deposits	2	0	2
M. Geol. 14.	Clays	2	0	2
M. Geol. 56.	Building Stones and Road Materials	3	0	3
Law 2.	General Mining Law	2	0	2
Pet. 5.	Microscopical Petrography	2	0	2
Pet. 14.	Petrographical Laboratory	0	6	2
		22	15	27

Spring Term

Ph. 3.	Logic	3	0	3
Geol. 15.	Metamorphism: Mineral and Rock Alteration	2	0	2
Mine 35.	First Aid to the Injured	0	3	1
Mine 38.	Mine Rescue Training	0	6	2
M. Ec. 3.	Mining Economics	2	0	2
M. Geol. 10.	Metallites or Metalliferous Deposits	2	0	2
M. Geol. 27.	Petroleum, Natural Gas, etc.	2	0	2
M. Geol. 38.	Saline and Gypsum Deposits	2	0	2
M. Geol. 61.	Mining Geology of Water	2	0	2
Law 3.	General Mining Law	2	0	2
Pet. 6.	Microscopical Petrography	2	0	2
Pet. 15.	Petrographical Laboratory	0	6	2
		22	15	27

FOURTH YEAR

Fall or Summer Term

No.	Subject	Class	Lab.	Credits
Sp. 30.	Spanish	3	0	3
Ger. 1.	German	3	0	3
Fr. 1.	French	3	0	3
M. Ec. 4.	Mining Economics	2	0	2
M. Geol. 11.	Genesis of Mineral Deposits	2	0	2
M. Geol. 21.	Gems or Precious Stones	2	0	2
M. Geol. 24.	Coal and Peat Deposits	2	0	2
M. Geol. 53.	Iron and Manganese Deposits	2	0	2
M. Geol. 39.	Copper Deposits	2	0	2
M. Geol. 42.	Gold Deposits	2	0	2
Pet. 7.	Microscopical Petrography	2	0	2
Pet. 16.	Petrographical Laboratory	0	6	2
		25	6	27

Winter Term

No.	Subject	Class	Lab.	Credits
Sp. 31.	Spanish	3	0	3
Ger. 1.	German	3	0	3
Fr. 1.	French	3	0	3
M. Ec. 5.	Mining Economics	2	0	2
M. Geol. 12.	Genesis of Mineral Deposits	2	0	2
M. Geol. 22.	Gems or Precious Stones	2	0	2
M. Geol. 25.	Coal and Peat Deposits	2	0	2
M. Geol. 34.	Iron and Manganese Deposits	2	0	2
M. Geol. 40.	Copper Deposits	2	0	2
M. Geol. 43.	Gold Deposits	2	0	2
Pet. 8.	Microscopical Petrography	2	0	2
Pet. 17.	Petrographical Laboratory	0	6	2
		25	6	27

Spring Term

Sp. 32.	Spanish	3	0	3
Ger. 1.	German	3	0	3
Fr. 1.	French	3	0	3
M. Ec. 6.	Mining Economics	2	0	2
M. Geol. 13.	Genesis of Mineral Deposits	2	0	2
M. Geol. 23.	Gems or Precious Stones	2	0	2
M. Geol. 26.	Coal and Peat Deposits	2	0	2
M. Geol. 34.	Iron and Manganese Deposits	2	0	2
M. Geol. 41.	Copper Deposits	2	0	2
M. Geol. 44.	Gold Deposits	2	0	2
Pet. 9.	Microscopical Petrography	2	0	2
Pet. 18.	Petrographical Laboratory	0	6	2
		25	6	27

MINING GEOLOGY

ADVISORY COURSE OF THE BACHELOR OF SCIENCE DEGREE IN MINING GEOLOGY

FIRST YEAR

Fall or Summer Term

No.	Subject	Class	Lab.	Credits
Ch. 1.	Inorganic Chemistry	2	6	4
Dr. 1.	Mechanical Drawing	0	3	1
En. 1.	English	3	0	3
Ger. 1.	German	3	0	3
Geol. 3.	General Geology	3	0	3
Geol. 6.	Botanical Geology	3	0	3
Min. 3.	Crystallography and Mineralogy	2	12	6
		16	21	23

Winter Term

No.	Subject	Class	Lab.	Credits
Ch. 2.	Inorganic Chemistry	2	6	4
Dr. 2.	Mechanical Drawing	0	3	1
Ast. 2.	General Astronomy	3	0	3
En. 2.	English	3	0	3
Ger. 2.	German	3	0	3
Geol. 4.	Stratigraphical Geology	3	0	3
Geol. 7.	Zoological Geology	3	0	3
Min. 4.	Mineralogy and Lithology	2	12	6
		17	21	26

Spring Term

Mat. 6.	Spherical Trigonometry	2	0	2
Ch. 8.	Qualitative Analysis	2	6	4
Dr. 3.	Mechanical Drawing	0	6	2
En. 3.	English	3	0	3
Ger. 3.	German	3	0	3
Geol. 50.	Field Geology	0	6	2
Min. 5.	Mineralogy and Lithology	2	12	6
M. Geol. 1.	Principles of Mining Geology	3	0	2
		13	30	25

Summer Term

M. Sur. 11.	Mining Surveying	0	50	23
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SECOND YEAR

Fall or Summer Term

No.	Subject	Class	Lab.	Credits
Ch. 9.	Quantitative Analysis	1	6	3
Phy. 1.	General Physics	3	3	4
Ger. 4.	Commercial German	3	0	3
Geol. 5.	Structural and Field Geology	3	0	3
Geol. 10.	Earths Origin and Structure	2	0	2
Geol. 52.	Field Geology and Geological			
	Surveying	0	6	2
Mine 1.	Principles of Mining	3	0	3
M. Geol. 5.	Mineral Wealth of North America	2	0	2
Pet. 1.	Optical Mineralogy	2	0	2
Pet. 10.	Petrographical Laboratory	0	6	2
		19	21	26

Winter Term

No.	Subject	Class	Lab.	Credits
Ch. 10.	Quantitative Analysis	1	6	3
Phy. 2.	General Physics	3	3	4
Ger. 4.	Commercial German	3	0	3
Geol. 11.	Vulcanism and Volcanos	2	0	2
Geol. 53.	Geological Mapping and Sketching	0	6	2
Met. 1.	Principles of Metallurgy	3	0	3
Met. 73.	Fire Assaying	1	6	3
M. Geol. 6.	Mineral Wealth of North America	2	0	2
Pet. 2.	Microscopical Mineralogy	2	0	2
Pet. 11.	Petrographical Laboratory	0	6	2

	18	27	27
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Spring Term

Ch. 11.	Quantitative Analysis	1	6	3
Phy. 3.	General Physics	3	3	4
P. Sp. 1.	Public Speaking	2	0	2
Ger. 5.	Commercial German	3	0	3
Geol. 12.	Earthquakes and Earth Movements	2	0	2
Geol. 16.	Chemical and Physical Geology—			
	Review	3	0	3
	Field Geology and Geological			
Geol. 54.	Surveying	0	6	2
M. Geol. 7.	Mineral Wealth of North America	2	0	2
Pet. 3.	Microscopical Mineralogy	2	0	2
Pet. 12.	Petrographical Laboratory	0	6	2

	18	21	25
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THIRD YEAR

Fall or Summer Term

No.	Subject	Class	Lab.	Credits
Fr. 1.	French	3	0	3
Sp. 30.	Spanish	3	0	3
Ec. 43.	Business Law	2	0	2
Psy.	General Psychology	3	0	3
Geol. 14.	Metamorphism: Mineral and Rock			
	Alteration	2	0	2
M. Ec. 1.	Mining Economics	2	0	2
M. Geol. 8.	Metallites or Metalliferous Deposits	2	0	2
Law 1.	Principles of Law and Mining Law	2	0	2
Ore 1.	Ore Dressing and Coal Washing	3	0	3
Pet. 4.	Microscopical Petrography	2	0	2
Pet. 13.	Petrographical Laboratory	0	6	2

	25	6	27
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Winter Term

No.	Subject	Class	Lab.	Credits
Fr. 2.	French	3	0	3
Sp. 31.	Spanish	3	0	3
Ec. 44.	Business Law	2	0	2
Ph. 1.	Ethics	3	0	3
Geol. 15.	Metamorphism: Mineral and Rock Alteration	2	0	2
Met. 83.	Wet Assaying	0	6	2
M. Ec. 2.	Mining Economics	2	0	2
M. Geol. 9.	Metallites or Metalliferous Deposits	2	0	2
M. Geol. 14.	Clays	2	0	2
M. Geol. 56.	Building Stones and Road Materials	3	0	3
Law 2.	General Mining Law	2	0	2
Pet. 5.	Microscopical Petrography	2	0	2
Pet. 14.	Petrographical Laboratory	0	6	2
		26	12	30

Spring Term

Fr. 3.	French	3	0	3
Sp. 32.	Spanish	3	0	3
Ec. 44.	Business Law	2	0	2
Ph. 3.	Logic	3	0	3
Geol. 15.	Metamorphism: Mineral and Rock Alteration	2	0	2
Mine 35.	First Aid to the Injured	0	3	1
Mine 38.	Mine Rescue Training	0	6	2
M. Ec. 3.	Mining Economics	2	0	2
M. Geol. 10.	Metallites or Metalliferous Deposits	2	0	2
Law 31.	General Mining Law	2	0	2
Pet. 6.	Microscopical Petrography	2	0	2
Pet. 15.	Petrographical Laboratory	0	6	2
		20	15	26

FOURTH YEAR

Fall or Summer Term

No.	Subject	Class	Lab.	Credits
En. 15.	English Literature	3	0	3
Fr. 7.	Technical French	3	0	3
Sp. 35.	Commercial Spanish	3	0	3
M. Ec. 4.	Mining Economics	2	0	2
M. Geol. 11.	Genesis of Mineral Deposits	2	0	2
M. Geol. 24.	Coal and Peat Deposits	2	0	2
M. Geol. 53.	Iron and Manganese Deposits	2	0	2
M. Geol. 39.	Copper Deposits	2	0	2
M. Geol. 42.	Gold Deposits	2	0	2
Pet. 7.	Microscopical Petrography	2	0	2
Pet. 16.	Petrographical Laboratory	0	6	2
		23	6	25

FOURTH YEAR

Winter Term

No.	Subject	Class	Lab.	Credits
En. 15.	English Literature	3	0	3
Fr. 8.	Technical French	3	0	3
Sp. 36.	Commercial Spanish	3	0	3
M. Ec. 5.	Mining Economics	2	0	2
M. Geol. 12.	Genesis of Mineral Deposits	2	0	2
M. Geol. 25.	Coal and Peat Deposits	2	0	2
M. Geol. 34.	Iron and Manganese Deposits	2	0	2
M. Geol. 40.	Copper Deposits	2	0	2
M. Geol. 43.	Gold Deposits	2	0	2
Pet. 8.	Microscopical Petrography	2	0	2
Pet. 17.	Petrographical Laboratory	0	6	2
		23	6	25

Spring Term

En. 16.	American Literature	3	0	3
Fr. 9.	Technical French	3	0	3
Sp. 37.	Commercial Spanish	3	0	3
M. Ec. 6.	Mining Economics	2	0	2
M. Geol. 13.	Genesis of Mineral Deposits	2	0	2
M. Geol. 26.	Coal and Peat Deposits	2	0	2
M. Geol. 34.	Iron and Manganese Deposits	2	0	2
M. Geol. 41.	Copper Deposits	2	0	2
M. Geol. 44.	Gold Deposits	2	0	2
Pet. 9.	Microscopical Petrography	2	0	2
Pet. 18.	Petrographical Laboratory	0	6	2
		23	6	25

ADVISORY TWO YEARS' COURSE IN MINING GEOLOGY

FIRST YEAR

Fall or Summer Term

No.	Subject	Class	Lab.	Credits
Ch. 1.	Inorganic Chemistry	2	6	4
Phy. 1.	General Physics	3	3	4
Dr. 1.	Mechanical Drawing	0	3	1
Geol. 3.	General Geology	3	0	3
Geol. 5.	Structural and Field Geology	3	0	3
Geol. 6.	Botanical Geology	3	0	3
Min. 3.	Crystallography and Mineralogy	2	12	6
Mine 1.	Elements of Mining	3	0	3
		19	24	27

Winter Term

No.	Subject	Class	Lab.	Credits
Ch. 2.	Inorganic Chemistry	2	6	4
Phy. 2.	General Physics	3	3	4
Dr. 2.	Mechanical Drawing	0	3	1
Ast. 2.	General Astronomy	3	0	3
Geol. 4.	Stratigraphical Geology	3	0	3
Geol. 7.	Zoological Geology	3	0	3
Met. 1.	General Metallurgy	3	0	3
Min. 4.	Mineralogy and Lithology	2	12	6
		19	24	27

Spring Term

Ch. 9.	Spherical Trigonometry	2	0	2
Ch. 8.	Qualitative Analysis	2	6	4
Phy. 3.	General Physics	3	3	4
Dr. 3.	Mechanical Drawing	0	6	2
Geol. 16.	Chemical and Physical Geology—			
	Review	3	0	3
Geol. 50.	Field Geology	0	6	2
Min. 5.	Mineralogy and Lithology	2	12	6
M. Geol. 1.	Principles of Mining Geology	3	0	3
		15	33	26

Summer Term

M. Sur. 11.	Mining Surveying	50	0	23
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SECOND YEAR

Fall or Summer Term

No.	Subject	Class	Lab.	Credits
Mat. 6.	Quantitative Analysis	1	6	3
Geol. 52.	Field Geology and Geological			
	Surveying	0	6	2
M. Ec. 1.	Mining Economics	2	0	2
M. Geol. 5.	Mineral Wealth of North America	2	0	2
M. Geol. 8.	Metallites or Metalliferous Deposits	2	0	2
M. Geol. 11.	Genesis of Mineral Deposits	2	0	2
M. Geol. 24.	Coal and Peat Deposits	2	0	2
M. Geol. 33.	Iron and Manganese Deposits	2	0	2
M. Geol. 36.	Saline and Gypsum Deposits	2	0	2
M. Geol. 39.	Copper Deposits	2	0	2
M. Geol. 42.	Gold and Silver Deposits	2	0	2
Law 1.	Elements of Law and Mining Law	2	0	2
Ore 1.	Ore Dressing and Coal Washing	3	0	3
		24	12	28

Winter Term

No.	Subject	Class	Lab.	Credits
Ch. 10.	Quantitative Analysis	1	6	3
Geol. 53.	Geological Mapping and Sketching	0	6	2
Met. 73.	Fire Assaying	1	6	3
M. Ec. 2.	Mining Economics	2	0	2
M. Geol. 6.	Mineral Wealth of North America	2	0	2
M. Geol. 9.	Metallites or Metalliferous Deposits	2	0	2
M. Geol. 12.	Genesis of Mineral Deposits	2	0	2
M. Geol. 24.	Coal and Peat Deposits	2	0	2
M. Geol. 33.	Iron and Manganese Deposits	2	0	2
M. Geol. 39.	Copper Deposits	2	0	2
M. Geol. 42.	Gold and Silver Deposits	2	0	2
M. Geol. 56.	Building and Ornamental Stones	3	0	3
Law 2.	General Mining Law	2	0	2
		23	18	29

Spring Term

Ch. 11.	Quantitative Analysis	1	6	3
Geol. 54.	Field Geology and Geological Surveying	0	6	2
Met. 83.	Wet Assaying	0	6	2
Mine 35.	First Aid to the Injured	0	3	1
Mine 38.	Mine Rescue Training	0	6	2
M. Ec. 3.	Mining Economics	2	0	2
M. Geol. 7.	Mineral Wealth of North America	2	0	2
M. Geol. 10.	Metallites or Metalliferous Deposits	2	0	2
M. Geol. 13.	Genesis of Mineral Deposits	2	0	2
M. Geol. 24.	Coal and Peat Deposits	2	0	2
M. Geol. 27.	Petroleum, Natural Gas, etc.	2	0	2
M. Geol. 33.	Iron and Manganese Deposits	2	0	2
M. Geol. 39.	Copper Deposits	2	0	2
M. Geol. 42.	Gold and Silver Deposits	2	0	2
Law 3.	General Mining Law	2	0	2
		21	27	30

GEOLOGY

ADVISORY COURSE FOR THE DEGREE OF GEOLOGICAL ENGINEER IN GEOLOGY

First Year is the same as the Advisory Course for Geological Engineer in Mining Geology.

SECOND YEAR

Fall or Summer Term

No.	Subject	Class	Lab.	Credits
Mat. 9.	Calculus	4	0	4
Ch. 9.	Quantitative Analysis	1	6	3
Phy. 11.	General Physics	4	3	5
Sur. 2.	Topography	1	6	3
Dr. 4.	Mechanical Drawing	0	6	2
Mine 1.	Elements of Mining	3	0	3
M. Geol. 5.	Mineral Wealth of North America	2	0	2

Selectives

Bio. 1.	General Biology	1	6	4
Geog. 1.	Physiography	2	0	2
Geol. 5.	Structural and Field Geology	3	0	3
Geol. 10.	Earth Origin and Structure	2	0	2
Geol. 26.	Paleozoic Geology	2	0	2
Geol. 52.	Field Geology and Geological Surveying	0	6	2
F. Bot. 1.	Paleobotany	2	0	2
F. Bot. 13.	Paleobotanical Laboratory	0	6	2
Min. 30.	Mathematical Crystallography	2	6	4
Pal. 1.	Invertebrate Paleontology	2	0	2
Pal. 27.	Paleontological Laboratory	0	6	2
Pet. 1.	Optical Mineralogy	2	0	2
Pet. 10.	Petrographical Laboratory	0	6	2

Winter Term

Mat. 9.	Calculus	4	0	4
Ch. 10.	Quantitative Analysis	1	6	3
Phy. 12.	General Physics	4	3	5
Sur. 3.	Topography	0	3	1
Met. 1.	Principles of Metallurgy	3	0	3
Met. 73.	Fire Assaying	1	6	3
M. Geol. 6.	Mineral Wealth of North America	2	0	2

Selectives

Bio. 2.	General Biology	1	6	4
Geog. 2.	Oceanography	2	0	2
Geol. 7.	Vulcanism and Volcanoes	2	0	2
Geol. 27.	Paleozoic Geology	2	0	2
Geol. 53.	Geological Mapping	0	6	2
Min. 31.	Mathematical Crystallography	2	6	4
F. Bot. 2.	Paleobotany	2	0	2
F. Bot. 14.	Paleobotanical Laboratory	0	6	2
Pal. 2.	Invertebrate Paleontology	2	0	2
Pal. 11.	Paleontological Laboratory	0	6	2
Pet. 2.	Microscopical Mineralogy	2	0	2
Pet. 11.	Petrographical Laboratory	0	6	2

Spring Term

No.	Subject	Class	Lab.	Credits
Mec. 1.	Analytic Mechanics	5	0	5
Ch. 11.	Quantitative Analysis	1	6	3
Phy. 13.	General Physics	4	3	5
Dr. 5.	Descriptive Geometry	2	6	4
M. Geol. 7.	Mineral Wealth of North America	2	0	2

Selectives

Bio. 8.	Advanced Zoology	2	6	5
Geog. 3.	Climatology	2	0	2
Geol. 12.	Earthquakes and Earth Movements	2	0	2
Geol. 16.	Physical and Chemical Geology— Review	3	0	3
Geol. 28.	Paleozoic Geology	2	0	2
Geol. 54.	Field Geology and Geological Surveying	0	6	2
Min. 32.	Mathematical Crystallography	2	6	4
F. Bot. 3.	Paleobotany	2	0	2
F. Bot. 15.	Paleobotanical Laboratory	0	6	2
Pal. 3.	Invertebrate Paleontology	2	0	2
Pal. 12.	Paleontological Laboratory	0	6	2
Pet. 3.	Microscopical Mineralogy	2	0	2
Pet. 12.	Petrographical Laboratory	0	6	2

THIRD YEAR

Fall or Summer Term

No.	Subject	Class	Lab.	Credits
Mec. 2.	Mechanics of Materials	5	0	5
Mec. 3.	Mechanical Laboratory	0	6	2
Ec. 43.	Business Law	2	0	2
Psy. 13.	General Psychology	3	0	3
M. Ec. 1.	Mining Economics	2	0	2
Law 1.	Principles of Law and Mining Law	2	0	2
Ore. 1.	Ore Dressing and Coal Washing	3	0	3

Selectives

Fr. 1 or 4.	French	3	0	3
Ger. 1 or 4.	German	3	0	3
Sp. 30.	Spanish	3	0	3
It. 40.	Italian	3	0	3
Geog. 4.	Advanced Physical Geography	2	0	2
Geol. 3.	Metamorphism: Mineral and Rock Alteration	2	0	2
Geol. 29.	Mesozoic and Cenozoic Geology	2	0	2
Geol. 35.	Glacial Geology	2	0	2
Geol. 44.	Geology of Pennsylvania	2	0	2

Selectives—Continued

No.	Subject	Class	Lab.	Credits
Geol. 74.	Geological Literature	2	0	2
Min. 33.	Physical Mineralogy	2	6	4
Min. 39.	Chemical Mineralogy	0	12	4
M. Geol. 8.	Metallites or Metalliferous Deposits	2	0	2
F. Bot. 4.	Paleobotany	2	0	2
F. Bot. 16.	Paleobotanical Laboratory	0	6	2
Pal. 4.	Invertebrate Paleontology	2	0	2
Pal. 15.	Vertebrate Paleontology	2	0	2
Pal. 30.	Paleontological Laboratory	0	6	2
Pal. 39.	Paleontological Laboratory	0	6	2
Pet. 4.	Microscopical Petrography	2	0	2
Pet. 13.	Petrographical Laboratory	0	6	2

Winter Term

Mec. 5.	Hydro-Mechanics and Hydraulics	4	0	4
Mec. 6.	Hydraulic Laboratory	0	3	1
Ph. 1.	Æthics	3	0	3
Ec. 44.	Business Law	2	0	2
M. Ec. 2.	Mining Economics	2	0	2
Law 2.	General Mining Law	2	0	2

Selectives

Fr. 2 or 5.	French	3	0	3
Ger. 2 or 5.	German	3	0	3
Sp. 31.	Spanish	3	0	3
It. 41.	Italian	3	0	3
Geog. 5.	Advanced Physical Geography	2	0	2
Geol. 14.	Metamorphism: Mineral and Rock Alteration	2	0	2
Geol. 30.	Mesozoic and Cenozoic Geology	2	0	2
Geol. 36.	Glacial Geology	2	0	2
Geol. 44.	Geology of Pennsylvania	2	0	2
Geol. 75.	Geological Literature	1	6	3
Min. 34.	Physical Mineralogy	2	6	4
Min. 39.	Chemical Mineralogy	0	12	4
M. Geol. 9.	Metallites or Metalliferous Deposits	2	0	2
F. Bot. 5.	Paleobotany	2	0	2
F. Bot. 17.	Paleobotanical Laboratory	0	6	2
Pal. 5.	Invertebrate Paleontology	2	0	2
Pal. 16.	Vertebrate Paleontology	2	0	2
Pal. 31.	Paleontological Laboratory	0	6	2
Pal. 40.	Paleontological Laboratory	0	6	2
Pet. 5.	Microscopical Petrography	2	0	2
Pet. 14.	Petrographical Laboratory	0	6	2

Spring Term

No.	Subject	Class	Lab.	Credits
Ph. 3.	Logic	3	0	3
Mine 35.	First Aid to the Injured	0	3	1
Mine 38.	Mine Rescue Training	0	6	2
M. Ec. 3.	Mining Economics	2	0	2
Law 3.	General Mining Law	2	0	2

Selectives

Fr. 3 or 6.	French	3	0	3
Ger. 3 or 6.	German	3	0	3
Sp. 32.	Spanish	3	0	3
It. 42.	Italian	3	0	3
Geog. 6.	Meteorology	2	0	2
Geol. 15.	Metamorphism: Mineral and Rock Alteration	2	0	2
Geol. 31.	Mesozoic and Cenozoic Geology	2	0	2
Geol. 37.	Glacial Geology	2	0	2
Geol. 45.	Geology of Pennsylvania	2	0	2
Geol. 76.	Geological Literature	1	6	2
Min. 35.	Physical Mineralogy	2	6	4
Min. 40.	Chemical Mineralogy	0	12	4
M. Geol. 10.	Metallites or Metalliferous Deposits	2	0	2
F. Bot. 6.	Paleobotany	2	0	2
F. Bot. 18.	Paleobotanical Laboratory	0	6	2
Pal. 6.	Invertebrate Paleontology	2	0	2
Pal. 17.	Vertebrate Paleontology	2	0	2
Pal. 32.	Paleontological Laboratory	0	6	2
Pal. 41.	Paleontological Laboratory	0	6	2
Pet. 6.	Microscopical Petrography	2	0	2
Pet. 15.	Petrographical Laboratory	0	6	2

Summer Term

Selectives

Geol. 70.	Practical Work in Geology	13 weeks.	18 credits.
Min. 48.	Practical Work in Mineralogy	13 weeks.	18 credits.
M. Geol. 105.	Practical Work in Mining Geology	13 weeks.	18 credits.

FOURTH YEAR

Fall or Summer Term

No.	Subject	Class	Lab.	Credits
Ec. 7.	Economic Resources	2	0	2
Law. 4.	Mining Contracts and Specifications	2	0	2

Selectives

No.	Subject	Class	Lab.	Credits
Fr. 4 or 7.	French or Technical French	3	0	3
Ger. 4 or 7.	German or Commercial German	3	0	3
Sp. 35.	Commercial Spanish	3	0	3
It. 43.	Italian	3	0	3
Geog. 7.	Economic Geography	2	0	2
Geog. 10.	Paleogeography	3	0	3
Geol. 17.	Azoic or Archæan Geology	2	0	2
Geol. 38.	Prehistoric Man	2	0	2
Geol. 41.	Geology of the United States	2	0	2
Geol. 60.	Field Geology, Geological Surveying	0	6	2
Geol. 64.	History of Geology	2	0	2
Geol. 71.	Geological Education	2	0	2
Min. 30.	Physical Mineralogy	2	6	4
Min. 42.	Chemical Mineralogy	0	12	4
M. Geol. 11.	The Genesis of Mineral Deposits	2	0	2
M. Geol. 24.	Coal and Peat Deposits	2	0	2
F. Bot. 7.	Paleobotany	2	0	2
F. Bot. 19.	Paleobotanical Laboratory	0	6	2
Pal. 7.	Invertebrate Paleontology	2	0	2
Pal. 18.	Vertebrate Paleontology	2	0	2
Pal. 33.	Paleontological Laboratory	0	6	2
Pal. 42.	Paleontological Laboratory	0	6	2
Pet. 7.	Microscopical Petrography	2	0	2
Pet. 16.	Petrographical Laboratory	0	6	2

Winter Term

Ec. 8.	Economic Resources	2	0	2
Law 5.	Mining Contracts and Specifications	2	0	2

Selectives

Fr. 5 or 8.	French or Technical French	3	0	3
Ger. 5 or 8.	German or Commercial German	3	0	3
Sp. 36.	Commercial Spanish	3	0	3
It. 44.	Italian	3	0	3
Geog. 8.	Economic Geography	2	0	2
Geog. 11.	Paleography	3	0	3
Geol. 18.	Azoic or Archæan Geology	2	0	2
Geol. 39.	Prehistoric Man	2	0	2
Geol. 42.	Geology of the United States	2	0	2
Geol. 61.	Geological Sketching and Mapping	0	6	2
Geol. 65.	History of Geological Research	2	0	2
Geol. 72.	Geological Education	2	0	2
Min. 31.	Physical Mineralogy	2	6	4

Selectives—Continued

No.	Subject	Class	Lab.	Credits
Min. 43.	Chemical Mineralogy	0	12	4
M. Geol. 12.	The Genesis of Mineral Deposits	2	0	2
M. Geol. 25.	Coal and Peat Deposits	2	0	2
F. Bot. 8.	Paleobotany	2	0	2
F. Bot. 20.	Paleobotanical Laboratory	0	6	2
Pal. 8.	Invertebrate Paleontology	2	0	2
Pal. 19.	Vertebrate Paleontology	2	0	2
Pal. 34.	Paleontological Laboratory	0	6	2
Pal. 42.	Paleontological Laboratory	0	6	2
Pet. 8.	Microscopical Petrography	2	0	2
Pet. 17.	Petrographical Laboratory	0	6	2

Spring Term

Ec. 9.	Economic Resources	2	0	2
Law 6.	Mining Contracts and Specifications	2	0	2

Selectives

Fr. 6 or 9.	French or Technical French	3	0	3
Ger. 6 or 9.	German or Commercial German	3	0	3
Sp. 37.	Commercial Spanish	3	0	3
It. 45.	Italian	3	0	3
Geog. 9.	Economic Geography	2	0	2
Geog. 12.	Paleography	3	0	3
Geol. 19.	Azoic or Archaean Geology	2	0	2
Geol. 40.	Prehistoric Man	2	0	2
Geol. 43.	Geology of the United States	2	0	2
Geol. 62.	Field Geology and Geological Surveying	0	6	2
Geol. 66.	History of Geological Research	2	0	2
Geol. 73.	Geological Education	2	0	2
Min. 32.	Physical Mineralogy	2	6	4
Min. 44.	Chemical Mineralogy	0	12	4
M. Geol. 13.	The Genesis of Mineral Deposits	2	0	2
M. Geol. 26.	Coal and Peat Deposits	2	0	2
F. Bot. 9.	Paleobotany	2	0	2
F. Bot. 21.	Paleobotanical Laboratory	0	6	2
Pal. 9.	Invertebrate Paleontology	2	0	2
Pal. 20.	Vertebrate Paleontology	2	0	2
Pal. 35.	Paleontological Laboratory	0	6	2
Pal. 43.	Paleontological Laboratory	0	6	2
Pet. 9.	Microscopical Petrography	2	0	2
Pet. 18.	Petrographical Laboratory	0	6	2

GEOLOGY

ADVISORY COURSE FOR THE BACHELOR OF SCIENCE DEGREE IN GEOLOGY

FIRST YEAR

First Year is the same as the Advisory Course for the Bachelor of Science Degree in Mining Geology.

SECOND YEAR

Fall or Summer Term

No.	Subject	Class	Lab.	Credits
Ch. 9.	Quantitative Analysis	1	6	3
Phy. 1.	General Physics	3	3	4
Ger. 4.	Commercial German	3	0	3
Dr. 4.	Mechanical Drawing	0	6	2
Mine 1.	Elements of Mining	3	0	3
M. Geol. 5.	Mineral Wealth of North America	2	0	2

Selectives

Bio. 1.	General Biology	1	6	4
Geog. 1.	Physiography	2	0	2
Geol. 5.	Structural and Field Geology	3	0	3
Geol. 10.	Earth Origin and Structure	2	0	2
Geol. 26.	Paleozoic Geology	2	0	2
Geol. 52.	Field Geology and Geological Surveying	0	6	2
Min. 30.	Mathematical Crystallography	2	6	4
F. Bot. 1.	Paleobotany	2	0	2
F. Bot. 13.	Palobotanical Laboratory	0	6	2
Pal. 1.	Invertebrate Paleontology	2	0	2
Pal. 27.	Paleontological Laboratory	0	6	2
Pet. 1.	Optical Mineralogy	2	0	2
Pet. 10.	Petrographical Laboratory	0	6	2

Winter Term

Ch. 10.	Quantitative Analysis	1	6	3
Phy. 2.	General Physics	3	3	4
Ger. 4.	Commercial German	3	0	3
Met. 1.	General Metallurgy	3	0	3
Met. 73.	Fire Assaying	1	6	3
M. Geol. 6.	Mineral Wealth of North America	2	0	2
Law 2.	General Mining Law	2	0	2

Selectives

No.	Subject	Class	Lab.	Credits
Bio. 2.	General Biology	1	6	4
Geog. 2.	Oceanography	2	0	2
Geol. 7.	Vulcanism and Volcanoes	2	0	2
Geol. 27.	Paleozoic Geology	2	0	2
Geol. 53.	Geological Sketching and Mapping	0	6	2
Min. 31.	Mathematical Crystallography	2	6	4
F. Bot. 2.	Paleobotany	2	0	2
F. Bot. 14.	Paleobotanical Laboratory	0	6	2
Pal. 2.	Invertebrate Paleontology	2	0	2
Pal. 11.	Paleontological Laboratory	0	6	2
Pet. 2.	Microscopical Mineralogy	2	0	2
Pet. 11.	Petrographical Laboratory	0	6	2

Spring Term

Ch. 11.	Quantitative Analysis	1	6	3
Phy. 3.	General Physics	3	3	4
P. Sp. 1.	Public Speaking	2	0	2
Ger. 5.	Commercial German	3	0	3
M. Geol. 7.	Mineral Wealth of North America	2	0	2

Selectives

Bio. 8.	Advanced Zoology	2	6	5
Geog. 3.	Climatology	2	0	2
Geol. 12.	Earthquakes and Earth Movements	2	0	2
Geol. 16.	Physical and Chemical Geology— Review	3	0	3
Geol. 28.	Paleozoic Geology	2	0	2
Geol. 54.	Field Geology and Geological Surveying	0	6	2
Min. 32.	Mathematical Crystallography	2	6	4
F. Bot. 3.	Paleobotany	2	0	2
F. Bot. 15.	Paleobotanical Laboratory	0	6	2
Pal. 3.	Invertebrate Paleontology	2	0	2
Pal. 12.	Paleontological Laboratory	0	6	2
Pet. 3.	Microscopical Mineralogy	2	0	2
Pet. 12.	Petrographical Laboratory	0	6	2

THIRD YEAR

Fall or Summer Term

No.	Subject	Class	Lab.	Credits
Psy. 13.	German Psychology	3	0	3
Ec. 43.	Business Law	2	0	2
M. Ec. 1.	Mining Economics	2	0	2
Law 1.	Principles of Law and Mining Law	2	0	2
Ore. 1.	Ore Dressing and Coal Washing	3	0	3

Selectives

No.	Subject	Class	Lab.	Credits
Fr. 1 or 4.	French	3	0	3
Sp. 30.	Spanish	3	0	3
It. 40.	Italian	3	0	3
Geog. 4.	Advanced Physical Geography	2	0	2
Geol. 13.	Metamorphism: Mineral and Rock Alteration	2	0	2
Geol. 29.	Mesozoic and Cenozoic Geology	2	0	2
Geol. 35.	Glacial Geology	2	0	2
Geol. 44.	Geology of Pennsylvania	2	0	2
Geol. 74.	Geological Literature	1	6	3
Min. 33.	Physical Mineralogy	2	6	4
Min. 39.	Chemical Mineralogy	0	12	4
M. Geol. 8.	Metallites or Metalliferous Deposits	2	0	2
F. Bot. 4.	Fossil Botany	2	0	2
F. Bot. 16.	Paleobotanical Laboratory	0	6	2
Pal. 4.	Invertebrate Paleontology	2	0	2
Pal. 15.	Vertebrate Paleontology	2	0	2
Pal. 30.	Paleontological Laboratory	0	6	2
Pal. 39.	Paleontological Laboratory	0	6	2
Pet. 4.	Microscopical Petrography	2	0	2
Pet. 13.	Petrographical Laboratory	0	6	2

Winter Term

Ph. 1.	Ethics	3	0	3
Ec. 44.	Business Law	2	0	2
M. Ec. 2.	Mining Economics	2	0	2
Law 2.	General Mining Law	2	0	2

Selectives

Fr. 2 or 5.	French	3	0	3
Sp. 31.	Spanish	3	0	3
It. 41.	Italian	3	0	3
Geog. 5.	Advanced Physical Geography	2	0	2
Geol. 14.	Metamorphism: Mineral and Rock Mesozoic and Cenozoic Geology	2	0	2
Geol. 30.	Mesozoic and Cenozoic Geology	2	0	2
Geol. 36.	Glacial Geology	2	0	2
Geol. 44.	Geology of Pennsylvania	2	0	2
Geol. 75.	Geological Literature	1	6	3
Min. 34.	Physical Mineralogy	2	6	4
Min. 39.	Chemical Mineralogy	0	12	4
M. Geol. 9.	Metallites or Metalliferous Deposits	2	0	2
F. Bot. 5.	Paleobotany	2	0	2
F. Bot. 17.	Paleobotanical Laboratory	0	6	2
Pal. 5.	Invertebrate Paleontology	2	0	2

Selectives—Continued

No.	Subject	Class	Lab.	Credits
Pal. 16.	Vertebrate Paleontology	2	0	2
Pal. 31.	Paleontological Laboratory	0	6	2
Pal. 40.	Paleontological Laboratory	0	6	2
Pet. 5.	Microscopic Petrography	2	0	2
Pet. 14.	Petrographical Laboratory			

The Spring and Summer Terms and the entire Fourth Year is the same as the Advisory Course given for the Degree of Geological Engineer in Geology with the exception of the German.

ADVISORY TWO YEARS' SHORT COURSE IN GEOLOGY

FIRST YEAR

Fall or Summer Term

No.	Subject	Class	Lab.	Credits
Ch. 1.	Inorganic Chemistry	2	6	4
Phy. 1.	General Physics	3	3	4
Dr. 1.	Mechanical Drawing	0	3	1
Geol. 3.	General Geology	3	0	3
Geol. 6.	Botanical Geology	3	0	3
Min. 3.	Crystallography and Mineralogy	2	12	6
Mine 1.	Elements of Mining	3	0	3

Selectives

Geog. 1.	Physiography	2	0	2
Geol. 5.	Structural and Field Geology	3	0	3
Geol. 10.	Earth Origin and Structure	2	0	2
Geol. 26.	Paleozoic Geology	2	0	2
Geol. 35.	Glacial Geology	2	0	2
Geol. 52.	Field Geology and Geological Surveying	0	6	2
F. Bot. 1.	Paleobotany	2	0	2
F. Bot. 13.	Paleobotanical Laboratory	0	6	2
Pal. 1.	Invertebrate Paleontology	2	0	2
Pal. 15.	Vertebrate Paleontology	2	0	2
Pal. 27.	Paleontological Laboratory	0	6	2
Pal. 39.	Paleontological Laboratory	0	6	2
Pet. 1.	Optical Mineralogy	2	0	2
Pet. 10.	Petrographical Laboratory	0	6	2

Winter Term

Ch. 2.	Inorganic Chemistry	2	6	4
Phy. 2.	General Physics	3	3	4
Dr. 2.	Mechanical Drawing	0	3	1
Geol. 4.	Stratigraphical Geology	3	0	3
Geol. 7.	Zoological Geology	3	0	3
Met. 1.	General Metallurgy	3	0	3
Min. 4.	Mineralogy and Lithology	2	12	6

Selectives

No.	Subject	Class	Lab.	Credits
Ast. 2.	General Astronomy	3	0	3
Geog. 2.	Oceanography	2	0	2
Geol. 11.	Vulcanism and Volcanoes	2	0	2
Geol. 26.	Paleozoic Geology	2	0	2
Geol. 35.	Glacial Geology	2	0	2
Geol. 53.	Geological Sketching and Mapping	0	6	2
F. Bot. 2.	Paleobotany	2	0	2
F. Bot. 14.	Paleobotanical Laboratory	0	6	2
Pal. 2.	Invertebrate Paleontology	2	0	2
Pal. 16.	Vertebrate Paleontology	2	0	2
Pal. 28.	Paleontological Laboratory	0	6	2
Pal. 40.	Paleontological Laboratory	0	6	2
Pet. 2.	Microscopical Mineralogy	2	0	2
Pet. 11.	Petrographical Laboratory	0	6	2

Spring Term

Mat. 6.	Special Trigonometry	2	0	2
Ch. 8.	Qualitative Analysis	2	6	4
Phy. 3.	General Physics	3	3	4
Dr. 3.	Mechanical Drawing	0	6	2
Min. 5.	Mineralogy and Lithology	2	12	6
M. Geol. 1.	Principles of Mining Geology	3	0	3

Selectives

Sur. 1.	Surveying	2	3	3
Geog. 3.	Climatology	2	0	2
Geol. 12.	Earthquakes and Earth Movements	2	0	2
Geol. 16.	Physical and Chemical Geology	3	0	3
Geol. 27.	Paleozoic Geology	2	0	2
Geol. 36.	Glacial Geology	2	0	2
Geol. 54.	Field Geology and Geological Surveying	0	6	2
F. Bot. 3.	Paleobotany	2	0	2
F. Bot. 15.	Paleobotanical Laboratory	0	6	2
Pal. 3.	Invertebrate Paleontology	2	0	2
Pal. 17.	Vertebrate Paleontology	2	0	2
Pal. 29.	Paleontological Laboratory	0	6	2
Pal. 41.	Paleontological Laboratory	0	6	2
Pet. 3.	Microscopical Mineralogy	2	0	2
Pet. 11.	Petrographical Laboratory	0	6	2

Summer Term

M. Sur. 11.	Surveying	50 hours.	23 credits.
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SECOND YEAR

Fall or Summer Term

No.	Subject	Class	Lab.	Credits
Ch. 9.	Quantitative Analysis	1	6	3
Ec. 43.	Business Law	2	0	2
Dr. 4.	Mechanical Drawing	0	6	2
M. Ec. 1.	Mining Economics	2	0	2
M. Geol. 5.	Mineral Wealth of North America	2	0	2
Law 1.	Principles of Law and Mining Law	2	0	2
Ore 1.	Ore Dressing and Coal Washing	3	0	3

Selectives

Geog. 4.	Advanced Physical Geography	2	0	2
Geog. 7.	Economic Geography	2	0	2
Geog. 10.	Paleogeography	3	0	3
Geol. 13.	Metamorphism: Mineral and Rock Alteration	2	0	2
Geol. 17.	Azoic and Archaean Geology	2	0	2
Geol. 29.	Mesozoic and Cenozoic Geology	2	0	2
Geol. 38.	Prehistoric Man	2	0	2
Geol. 41.	Geology of United States	2	0	2
Geol. 44.	Geology of Pennsylvania	2	0	2
Geol. 74.	Geological Literature	1	6	3
M. Geol. 8.	Metallites or Metalliferous Deposits	2	0	2
M. Geol. 24.	Coal and Peat Deposits	2	0	2
F. Bot. 4.	Paleobotany	2	0	2
F. Bot. 16.	Paleobotanical Laboratory	0	6	2
Pal. 4.	Invertebrate Paleontology	2	0	2
Pal. 18.	Vertebrate Paleontology	2	0	2
Pal. 30.	Paleontological Laboratory	0	6	2
Pal. 42.	Paleontological Laboratory	0	6	2
Pet. 4.	Microscopical Petrography	2	0	2
Pet. 13.	Petrographical Laboratory	0	6	2

Winter Term

Ch. 10.	Quantitative Analysis	1	6	3
Ec. 44.	Business Law	2	0	2
M. Ec. 2.	Mining Economics	2	0	2
M. Geol. 6.	Mineral Wealth of North America	2	0	2
Law 2.	General Mining Law	2	0	2

Selectives

Geog. 5.	Advanced Physical Geography	2	0	2
Geog. 8.	Economic Geography	2	0	2
Geog. 11.	Paleogeography	3	0	3
Geol. 14.	Metamorphism: Mineral and Rock Alteration	2	0	2

Selectives—Continued

No.	Subject	Class	Lab.	Credits
Geol. 18.	Azoic or Archaean Geology	2	0	2
Geol. 30.	Mesozoic and Cenozoic Geology	2	0	2
Geol. 39.	Prehistoric Man	2	0	2
Geol. 42.	Geology of United States	2	0	2
Geol. 45.	Geology of Pennsylvania	2	0	2
Geol. 74.	Geological Literature	1	6	3
M. Geol. 9.	Metallites or Metalliferous Deposits	2	0	2
M. Geol. 25.	Coal and Peat Deposits	2	0	2
F. Bot. 5.	Paleobotany	2	0	2
F. Bot. 17.	Paleobotanical Laboratory	0	6	2
Pal. 5.	Invertebrate Paleontology	2	0	2
Pal. 19.	Vertebrate Paleontology	2	0	2
Pal. 31.	Paleontological Laboratory	0	6	2
Pal. 43.	Paleontological Laboratory	0	6	2
Pet. 5.	Microscopical Petrography	2	0	2
Pet. 14.	Petrographical Laboratory	0	6	2

Spring Term

Ch. 11.	Quantitative Analysis	1	6	3
Ec. 45.	Business Law	2	0	2
M. Ec. 2.	Mining Economics	2	0	2
M. Geol. 6.	Mineral Wealth of North America	2	0	2
Law 3.	General Mining Law	2	0	2

Selectives

Geog. 6.	Advanced Physical Geography	2	0	2
Geog. 8.	Economic Geography	2	0	2
Geog. 12.	Paleogeography	3	0	3
Geol. 15.	Metamorphism: Mineral and Rock Alteration	2	0	2
Geol. 18.	Azoic or Archaean Geology	2	0	2
Geol. 31.	Mesozoic and Cenozoic Geology	2	0	2
Geol. 40.	Prehistoric Man	2	0	2
Geol. 43.	Geology of United States	2	0	2
Geol. 46.	Geology of Pennsylvania	2	0	2
Geol. 75.	Geological Literature	1	6	3
M. Geol. 10.	Metallites or Metalliferous Deposits	2	0	2
M. Geol. 26.	Coal and Peat Deposits	2	0	2
F. Bot. 6.	Paleobotany	2	0	2
F. Bot. 18.	Paleobotanical Laboratory	0	6	2
Pal. 6.	Invertebrate Paleontology	2	0	2
Pal. 20.	Vertebrate Paleontology	2	0	2
Pal. 32.	Paleontological Laboratory	0	6	2
Pal. 44.	Paleontological Laboratory	0	6	2
Pet. 6.	Microscopical Petrography	2	0	2
Pet. 15.	Petrographical Laboratory	0	6	2

CERAMICS

ADVISORY COURSE FOR THE DEGREE OF CERAMIC ENGINEER

FIRST YEAR

The same as the first year for the Degree of Geological Engineer in Mining Geology.

SECOND YEAR

Fall or Summer Term

No.	Subject	Class	Lab.	Credits
Ch. 9.	Quantitative Analysis	1	6	3
Mat. 9.	Calculus	4	0	4
Dr. 4.	Mechanical Sketching	0	6	2
Fr. 1.	French	3	0	3
Ger. 1.	German	3	0	3
Phy. 11.	General Physics	4	3	5
Geol. 48.	Field Geology	0	6	2
Mine 1.	Elements of Mining	3	0	3
M. Geol. 5.	Mineral Wealth of North America	2	0	2
		20	21	27

Winter Term

Ch. 10.	Quantitative Analysis	1	6	3
Mat. 10.	Calculus	4	0	4
Dr. 5.	Descriptive Geometry	4	0	4
Fr. 2.	French	3	0	3
Ger. 2.	German	3	0	3
Phy. 12.	General Physics	4	3	5
Geol. 49.	Geological Mapping	0	6	2
M. Geol. 6.	Mineral Wealth of North America	3	0	3
		21	15	27

Spring Term

Ch. 11.	Quantitative Analysis	1	6	3
Dr. 6.	Applied Descriptive Geometry	2	0	2
Phy. 13.	General Physics	0	0	5
C. E. 1.	Surveying	2	3	3
Mech. 1.	Analytic Mechanics	5	0	5
Ger. 3.	German	3	0	3
Fr. 3.	French	3	0	3
Geol. 50.	Field Geology	0	6	0
M. Geol. 7.	Mineral Wealth of North America	2	0	2
		18	15	26

THIRD YEAR

Fall Term

No.	Subject	Class	Lab.	Credits
Mec. 2.	Mechanics of Materials	5	0	5
Mec. 3.	Mechanical Laboratory	0	6	2
M. Geol. 14.	Clays, etc.	2	0	2
Cer. 1.	Clay Testing	2	0	2
Pet. 1.	Optical Mineralogy	2	0	2
Pet. 10.	Petrographic Laboratory	0	6	2
Met. 1.	General Metallurgy	3	0	3
Ore 1.	Principles of Ore Dressing	3	0	3
M. E. 1.	Kinematics	3	0	3
Cer. 34.	Ceramic Laboratory	0	6	2
		20	18	26

Winter Term

E. E. 2.	Applied Electricity	2	3	3
Mec. 4.	Graphic Statics.	3	0	3
M. Geol. 15.	Clays, etc.	2	0	2
Cer. 2.	Clay Testing	2	0	2
Pet. 2.	Optical Mineralogy	2	0	2
Pet. 11.	Petrographic Laboratory	0	6	2
Ore 2.	Ore Dressing	3	0	3
Econ. 16.	Industrial Management	2	0	2
Mine 41.	Mine Calculations	3	0	3
Cer. 35.	Ceramic Laboratory	0	6	2
		19	15	24

Spring Term

Mech. 5.	Hydraulics	4	0	4
Mech. 6.	Hydraulic Laboratory	0	3	1
C. E. 7.	Masonry Construction	2	0	2
M. E. 2.	Machine Design	2	6	4
M. Geol. 16.	Clays	2	0	2
Cer. 3.	Clay Testing	2	0	2
Pet. 3.	Optical Mineralogy	2	0	2
Pet. 12.	Petrographical Laboratory	0	6	2
Ore 3.	Principles of Ore Dressing	3	0	3
P. Sp. 1.	Public Speaking	2	0	2
Cer. 36.	Ceramic Laboratory	0	6	2
		19	21	26

FOURTH YEAR

Fall Term

No.	Subject	Class	Lab.	Credits
M. E. 3.	Public Speaking	2	0	2
Ch. 12.	Machine Design	1	6	3
P. Sp. 2.	Quantitative Analysis	1	6	3
Cer. 37.	Calorimetry, etc.	2	0	2
Cer. 7.	Principles of Law	2	0	2
Cer. 13.	Lime and Cement	1	3	2
Met. 2.	Manufacture of Glass	2	0	2
Law 1.	Ceramic Laboratory	0	6	2
	Electives			5
				23

Winter Term

Ch. 13.	Quantitative Analysis	1	6	3
Cer. 8.	Furnaces and Refractories	2	0	2
Cer. 14.	Mining Law	2	0	2
Cer. 38.	Limes and Cement	1	3	2
Met. 3.	Glass Manufacture	2	0	2
Law 2.	Ceramic Laboratory	0	6	2
	Electives			10
				23

Spring Term

Ch. 14.	Quantitative Analysis	1	6	3
P. Sp. 3.	Public Speaking	2	0	2
Cer. 9.	Limes and Cements	1	3	2
Cer. 14.	Glass Manufacture	2	0	2
Cer. 39.	Ceramic Laboratory	0	6	2
Met. 4.	Furnaces and Refractories	2	0	2
Law 3.	Mining Law	2	0	2
	Electives			5
				23

ADVISORY COURSE FOR THE DEGREE OF BACHELOR OF
SCIENCE IN CERAMICS

FIRST YEAR

The same as that for the Bachelor of Science Degree in Mining Geology.

SECOND YEAR

Fall or Summer Term

No.	Subject	Class	Lab.	Credits
Ch. 9.	Quantitative Analysis	1	6	3
Phy. 1.	General Physics	3	3	4
Fr. 1.	French	3	0	3
Geol. 48.	Field Geology	0	6	2
Mine 1.	Elements of Mining	3	0	3
P. Sp. 2.	Public Speaking	2	0	2
M. Geol. 5.	Mineral Wealth of North America	2	0	2
Bio. 1.	General Biology	1	6	4
Pet. 1.	Optical Mineralogy	2	0	2
Pet. 10.	Petrographical Laboratory	0	6	2
		14	24	27

Winter Term

Ch. 10.	Qualitative Analysis	1	6	3
Phy. 2.	General Physics	3	3	4
Fr. 2.	French	3	0	3
Geol. 49.	Field Geology	0	6	2
Bio. 2.	General Biology	1	6	4
M. Geol. 6.	Mineral Wealth of North America	2	0	2
Pet. 2.	Microscopical Mineralogy	2	0	2
Pet. 11.	Petrographical Laboratory	0	6	2
		12	27	22

Spring Term

Mat. 6.	Spherical Trigonometry	2	0	2
Ch. 11.	Quantitative Analysis	1	6	3
Phy. 3.	General Physics	3	3	4
Geol. 50.	Field Geology	0	6	2
M. Geol. 7.	Mineral Wealth of North America	2	0	2
Sur. 1.	Surveying	2	3	3
P. Sp. 3.	Public Speaking	2	0	2
Pet. 3.	Microscopical Mineralogy	2	0	2
Fr. 3.	French	3	0	3
Pet. 12.	Petrographical Laboratory	0	6	2
		17	24	23

THIRD YEAR

Fall or Summer Term

No.	Subject	Class	Lab.	Credits
M. Geol. 14.	Clays	2	0	2
Pet. 4.	Optical Mineralogy	2	0	2
Pet. 13.	Petrographic Laboratory	0	6	2
Met. 1.	General Metallurgy	3	0	3

Fall or Summer Term—Continued

No.	Subject	Class	Lab.	Credits
Ore 1.	Ore Dressing	3	0	3
Cer. 1.	Clay Testing	2	0	2
Cer. 34.	Ceramic Laboratory	0	6	2
M. Ec. 1.	Mining Economics	2	0	2
Psy. 13.	General Psychology	3	0	3
Ch. 12.	Quantitative Analysis	1	6	3
		18	18	24

Winter Term

M. Geol. 15.	Clays	2	0	2
Pet. 5.	Optical Mineralogy	2	0	2
Pet. 14.	Petrographic Laboratory	0	6	2
Met. 2.	Calorimetry, etc.	2	0	2
Ore 2.	Ore Dressing	3	0	3
Cer. 2.	Clay Testing	2	0	2
Cer. 35.	Ceramic Laboratory	0	6	2
M. Ec. 2.	Mining Economics	2	0	2
Ph. 1.	Ethics	3	0	3
Ch. 13.	Quantitative Analysis	1	6	3
		17	18	21

Spring Term

M. Geol. 16.	Clays	2	0	2
Pet. 6.	Optical Mineralogy	2	0	2
Pet. 15.	Petrographic Laboratory	0	6	2
Met. 3.	Calorimetry, etc.	2	0	2
Ore 3.	Ore Dressing	3	0	3
Cer. 3.	Clay Testing	2	0	2
Cer. 36.	Ceramic Laboratory	0	6	2
M. Ec. 3.	Mining Economics	2	0	2
Ph. 3.	Logic	3	0	3
Ch. 14.	Quantitative Analysis	1	6	3
		17	18	23

FOURTH YEAR

Fall or Summer Term

No.	Subject	Class	Lab.	Credits
Law 1.	Principles of Law	2	0	2
Ec. 13.	Modern Industries	2	0	2
Cer. 7.	Limes and Cements	2	0	2
Cer. 13.	Glass Manufacturing	2	0	2
Cer. 37.	Ceramic Laboratory	0	6	2
Electives				13

Winter Term

No.	Subject	Class	Lab.	Credits
Law 2.	Mining Law	2	0	2
Ec. 16.	Industrial Management	3	0	2
Cer. 8.	Limes and Cements	2	0	2
Cer. 14.	Glass Manufacturing	2	0	2
Cer. 38.	Ceramic Laboratory	2	0	2
	Electives			13

Spring Term

Law 3.	Mining Law	2	0	2
Ec. 19.	Labor Problems	3	0	3
Cer. 9.	Limes and Cements	2	0	2
Cer. 14.	Glass Manufacture	2	0	2
Cer. 38.	Ceramic Laboratory	2	0	2
	Electives			12

ADVISORY TWO YEARS' COURSE IN CERAMICS

FIRST YEAR

Fall or Summer Term

No.	Subject	Class	Lab.	Credits
Ch. 1.	Inorganic Chemistry	2	6	4
Geol. 3.	General Geology	3	0	3
Dr. 1.	Mechanical Drawing	0	3	1
Min. 3.	Crystallography and Mineralogy	2	12	6
Ger. 1.	German	3	0	3
M. Geol. 14.	Clays	2	0	2
Cer. 34.	Ceramic Laboratory	0	6	2
Cer. 1.	Clay Testing	2	0	2
Mine 1.	Elements of Mining	3	0	3
		17	15	26

Winter Term

Ch. 2.	Inorganic Chemistry	2	6	4
Geol. 4.	Stratigraphic Geology	3	0	3
Dr. 2.	Mechanical Drawing	0	3	1
Ger. 2.	Elem. German	3	0	3
M. Geol. 15.	Clays	2	0	2
Cer. 35.	Ceramic Laboratory	0	6	2
Cer. 2.	Clay Testing	2	0	2
Min. 4.	Mineralogy and Lithology	2	12	6
		14	27	23

Spring Term

No.	Subject	Class	Lab.	Credits
Ch. 8.	Qualitative Analysis	2	6	4
Geol. 5.	Structural and Field Geology	3	0	3
Dr. 3.	Mechanical Drawing	2	0	2
M. Geol. 1.	Principles of Mining Geology	3	0	3
Ger. 3.	German	3	0	3
M. Geol. 16.	Clays	2	0	2
Cer. 36.	Ceramic Laboratory	0	6	2
Cer. 3.	Clay Testing	2	0	2
Min. 5.	Mineralogy and Lithology	2	12	6
Sur. 1.	Surveying	2	3	3
		21	27	30

SECOND YEAR

Fall or Summer Term

No.	Subject	Class	Lab.	Credits
Met. 1.	General Metallurgy	3	0	3
Ch. 9.	Quantitative Analysis	1	6	3
Geol. 48.	Field Geology	0	6	2
Phy.	General Physics	3	3	4
Cer. 7.	Lime and Cement Materials	2	0	2
Cer. 37.	Ceramic Laboratory	0	6	2
Cer. 31.	Ceramic Calculations	2	0	2
	Electives			5

Winter Term

Ch. 10.	Quantitative Analysis	1	6	3
Geol. 49.	Field Geology	0	6	2
Phy. 2.	General Physics	3	3	4
Cer. 8.	Limes and Cement Materials	2	0	2
Cer. 38.	Ceramic Laboratory	0	6	2
Cer. 32.	Ceramic Calculations	2	0	2
	Electives			8

Spring Term

Ch. 11.	Quantitative Analysis	1	6	3
Geol. 50.	Field Geology	0	6	2
Phy. 3.	General Physics	3	3	4
Cer. 8.	Lime and Cement Materials	2	0	2
Cer. 38.	Ceramic Laboratory	0	6	2
Cer. 32.	Ceramic Calculations	2	0	2
	Electives			8

REGULATIONS OF THE SCHOOL OF MINES

DISCIPLINE

No student shall be allowed to remain a member of the School or be connected with it in any way if his conduct shall be considered prejudicial to the interests of the School.

Any student who presents as his own the work of someone else, or who falsifies or cheats in any of his School relations, shall by that act stand automatically dismissed from the School.

A student having conditions amounting to 9 credits at any time is by that fact automatically dropped from the School.

A student standing dismissed by the instructors from two subjects at the same time, on account of absence, improper conduct, poor scholarship or from any other cause, becomes by that fact dismissed from the School.

INSTRUCTORS

Each instructor is the sole judge of the fitness of every student taking his subjects. He may refuse to admit into his class any student found deficient in preparation, or dismiss him from his subject, after due warning, at any time when he has too many absences or when his conduct or work is unsatisfactory. Written information of this dismissal, and the reason therefor, shall at once be sent to the Dean.

Each instructor shall be charged with the personal supervision of the work in his subject or subjects, and shall inform the student, upon his request, from time to time of his status.

Each instructor has charge of the absences, conduct, and work of the students when in his class, and he shall keep a record of the absences, and the work of each student under his charge.

No instructor will be retained unless he maintains good order in his class rooms and laboratories and proves himself an efficient teacher.

The grade and absences of a student shall be reported to the Dean of the School by each instructor at the end of each term or when the subject has been concluded. The instructor may grade the student from his daily work or from examinations, or both, as seems best, but no student shall receive credit for any partially completed subject. The grades are also to be reported to the Registrar as provided in the College regulations.

EXAMINATIONS

Examinations are to be held, or not, at the end of the Term or when the work is finished in each subject, as each instructor may decide, and for such part or all of his students as he directs.

An examination for the removal of a condition incurred in one term can be had only at the beginning of the next term in which the same course is taught, and only one re-examination is allowed. No

instructor is required to give more than one re-examination in any subject at the beginning of any term. In the case of Seniors and Second Year Short Course Students, the method and time of the removal of their conditions are to be arranged by means of petitions approved by the instructors concerned and the Dean, but all examinations in one subject are to be given at the same time.

GRADES

Student grades are given at the close of each term by classification, as follows:

A, signifying very high—approximately 90 to 100%

B, signifying high—approximately 80 to 90%

C, signifying good—approximately 70 to 80%

D, signifying poor, barely passed—approximately 60 to 70%

E, signifying a failure, which may be made up by subsequent study and examination—approximately 50 to 60%

F, signifying total failure, which can only be made up by taking the subject over again in the class, but the instructor has the right to mark any student failing to pass, with an F, instead of an E if he judges the subject should be repeated.

G, signifying incomplete; that is, that the work upon the course is incomplete, therefore, the grade is still undetermined.

No student will be recommended for graduation whose record shows any incomplete work (G).

The method of making up will depend upon the individual case.

All missed work must be made up or ranked as Zero, but unless the student's excuse is satisfactory the instructor is not required to allow any student to make the work up.

PETITIONS

Every question formally presented to the School or to the Dean shall be in the form of a written petition, and every petition must have upon it the written approval of every officer directly concerned before presentation to the Dean of the School. If it is approved by the Dean, the petition is granted, and the Dean will so notify the student and all the parties concerned.

A student dropped or excluded from any class or the School for any cause, or by any rule, can only be restored under this regulation.

FIXED AND ELECTIVE SUBJECTS

Choice of subjects for any term must be placed in the hands of the Dean of the School, *in writing*, not less than three weeks before the end of the preceding term.

After the subjects have been chosen for any term a student can change, drop or take up any study, either elective or required, only in the following manner: He is to hand to the Dean a written request,

stating the change desired and the reason therefor. This petition, before it is placed in the Dean's hands, is to bear the written approval of each and every instructor affected by the proposed change. If it shall then be approved by the Dean, the change may be made, and the Dean shall notify the student and the instructors concerned.

Further, the work already done in the subject from which the change is made will not be counted, but the student will be obliged to complete all the required work in the subject to which he is transferred, the same as if the latter subject had been originally chosen.

Any student failing to hand in to the Dean lists of his studies, both required and elective, by the time specified, or who drops or takes up any study except in the manner here stated, is by that fact dropped from all further exercises in the School until he is reinstated by petition in the manner specified, except in case of those students who do not intend to continue in the School.

Each student must show to each of his instructors a schedule for that Term, signed by the Dean, before any instructor is to admit that student to his class; while the student must obtain upon the back of his schedule the signature of every instructor whose work has been selected before the schedule is to be signed by the Dean.

Subjects are to be taken in sequence, but not necessarily in any specified year.

In exceptional cases, a student may be allowed by the Dean to take a subject out of sequence, if the student presents a petition giving the reasons therefor, and bearing the written approval of the instructors in the preparatory subjects and the instructor in the subject to be taken.

A student taking any subject will be required to complete it, unless he drops it during the term by petition as above stated, before he can be recommended for graduation.

GRADUATE STUDENTS

Students who have received a Bachelor of Science or an Engineering Degree in this School, or in one whose course can be accepted as an equivalent, will be admitted to pursue graduate studies in the School of Mines.

The courses may be selected from the graduate and undergraduate subjects under the direction of the Dean and the instructors concerned.

CREDITS

Undergraduates and graduates of universities, colleges or other technical schools shall receive provisional credits for all work taken in the school from whence they come, for which they present the proper credits and which are the apparent equivalents of subjects taught in this School. If, after a suitable length of time, the student proves his work to have been the equivalent of the work required in this School, his provisional credits shall become permanent, and each instructor concerned shall so certify to the Dean of the School and to the Registrar. Otherwise the student shall receive no credit for work done in other institutions.

REGISTER OF STUDENTS

ATTENDANCE 1909-1910.

GRADUATE STUDENTS

ACKER, LOUIS KOSSUTH, JR., E. M., <i>University of Pittsburgh</i> , Pittsburgh	Mining Geology
FISCHER, WILLIAM FREDERICK, E.M., <i>University of Pittsburgh</i> , Pittsburgh	Petrography
HALDEMAN, GEORGE THOMPSON, E.M., <i>University of Pittsburgh</i> ,	Mining Pittsburgh
SMITH, LLOYD BEECHER, B.S. (Mining), <i>Pennsylvania State College</i> ,	Mining Geology Pittsburgh

SENIOR CLASS

COLE, WALTER RAY	Beaver Falls
LEWIS, REED MORRISON	West Etna
MELLER, HARRY BERTINE	Philadelphia
RAMSEY, FRANK HOWARD	N. S., Pittsburgh
ZIEG, WALDEMAR WILLIAM	N. S., Pittsburgh

JUNIOR CLASS

CREA, JAMES HARRISON	Mars
ESTABROOK, NED LEWIS	Platteville, Wis.
HUMPHRIES, WILLIAM HOWARD	Vance Mills
MACLEOD, JAMES THOMPSON	Wilkinsburg
MOHLER, KARL IRWIN	Freedom
PETERS, CHARLES MEADE	Ben Avon

SOPHOMORE CLASS

BISHOFF, AVERY	Rankin
CARSON, JOSEPH RANDALL	Pittsburgh
FLEMING, JAMES RUSSELL	New Alexandria
FREEMAN, MITCHELL	Pittsburgh
JANDORF, MORTON LEHMAYER	York
KELLER, JOSEPH BLAKE	Scottdale
MACKRELL, JAMES CLARENCE, JR.....	Pittsburgh
MARCUS, MORRIS M.....	Pittsburgh
REGAN, FRANK WILLIAM	Cleveland, O.
ROSS, HARRY EARLE	N. S., Pittsburgh
ROY, UPENDRA NATH	Chittagong, India
WYNNE, IRA HAROLD	Glenwillard
YOST, RAYMOND GEORGE	Pittsburgh

FRESHMAN CLASS

GEARY, PAUL XAVIER	Wilkinsburg
HALL, CHALMERS	Pittsburgh
MORELLI, CHARLES OTTO	Mt. Lebanon
M McNARY, CAMPBELL	Ingram
WEHS, JOSEPH GEORGE	N. S., Pittsburgh
WRIGHT, ARTHUR PARK	Pittsburgh

SPECIAL STUDENTS

FITZHARRIS, JOSEPH CHRISTOPHER	Tarentum
GRAY, PHILIP	Pittsburgh
GREGG, EDWARD THOMAS	Aspinwall
KNEFF, CLINTON WILLIAM.....	Pittsburgh
McCABE, HOWARD H.....	N. S., Pittsburgh
MITCHELL, DONALD WORRELL.....	Plains
PARSONS, MARTHA REED	Ingram
PORTER, JOHN III.	McKeesport
REITH, AUGUST	Pittsburgh
WASSON, EARL STANLEY	Pittsburgh

ATTENDANCE 1910-1911.

GRADUATE STUDENTS*

BELL, MARCUS LEWELLYN, B.S., <i>Alfred University</i>	Wilkesburg Metallurgy
BRUCE, JAMES KENNEDY, B.S., <i>Albright College</i>	Knoxville Metallurgy
EATON, HARRY NELSON, A.B., <i>Colgate University</i> ; A.M., <i>Harvard University</i>	Pittsburgh Geology and Petrography
EVANS, WALTER FILMER, A.B., <i>Yale University</i>	Pittsburgh Metallurgy
FIELDNER, ARNO CARL, B.S., <i>Ohio State</i>	Pittsburgh Geology
HALDEMAN, GEORGE THOMPSON, E.M., <i>University of Pittsburgh</i> , Scranton	Mining
HECHT, MAX, B.S., <i>College City of New York</i>	Pittsburgh Geology
ISENBERG, HAROLD, B.S., <i>Rose Polytechnic Institute</i>	Pittsburgh Geology
LEIGHTON, HENRY, A.B., <i>Cornell University</i>	Wilkesburg Mining Geology
MELLER, HARRY BERTINE, E.M., <i>University of Pittsburgh</i>	Pittsburgh Mining
OVITZ, FRANK KEELIN, B.S., <i>University of Michigan</i>	Pittsburgh Geology
PHYTHYON, HARRY, B.S., <i>Westminster College</i>	West Middlesex Mining
PHYTHYON, HARRY, B.S., <i>Westminster College</i>	West Middlesex Mining
RAY, HORATIO CADWALLADER, B.S., <i>Pennsylvania State College</i> , Pittsburgh	Metallurgy
STANTON, FREDERIC MOSES, B.S., <i>Ohio State University</i>	Pittsburgh Petrography
THOMPSON, LOUGHMAN SCOTT, A.B., <i>Yale University</i>	Pittsburgh Metallurgy
TWITCHELL, RENEL LINCOLN, A.B., <i>Yale University</i>	Pittsburgh Metallurgy
ZIEMBA, KASIMER MARTIN, E.M., <i>Leoben Bergakademie</i>	Maerisch, Ostran, Austria Metallurgy

UNDERGRADUATE STUDENTS

ALLEN, WALTER JOSEPH.....	Wilkinsburg
ALEXANDER, FRANK CREIGHTON	Pittsburgh
BANNISTER, AMOS HAROLD.....	Beaver Falls
BEVIER, GEORGE MEANS	Pittsburgh
BLACK, HERBERT FRANCIS	Pittsburgh
BLACKBURN, ROBERT BRECKINRIDGE.....	Oakmont
BLAKELY, JESSE	Coraopolis
BOSE, AMULYA CHANDRA.....	Calcutta, India
BRENNEMAN, LOUIS PHILIP	Pottsville
CARTWRIGHT, ROBERT METSCH.....	East Liverpool, O.
COLLEY, MYRON LAMONTE	Muncy
CREA, JAMES HARRISON.....	Mars
ESTABROOK, EDWARD LEWIS	Platteville, Wis.
FEINBERG, PHILIP	Beaver Falls
FLEMING, JAMES RUSSELL	New Alexandria
FOLLANSBEE, MARCUS ACHESON	Pittsburgh
FOSTER, FRANK BUSH	Beaver
FREEMAN, MITCHELL	Pittsburgh
FRITZ, JOSIAH LEONARD	Benton
GEARY, PAUL XAVIER	Wilkinsburg
HALL, CHALMERS	Pittsburgh
HARRIS, SAMUEL JASON	Bellevue
HINCKLEY, JOHN F.	Pittsburgh
HITZFELDT, WALTER	Wilkinsburg
HUMPHRIES, WILLIAM HOWARD	Latrobe
JANDORF, MORTON LEHMAYER	York
MACKRELL, JAMES CLARENCE, JR.....	Pittsburgh
MACLEOD, JAMES THOMPSON	Wilkinsburg
MARCUS, MORRIS M.	Pittsburgh
MOHLER, KARL IRWIN	Freedom
MOSS, ROY BINGHAM	Pineville, Ky.
MUKERJI, PRAFULLA CHANDRA	Calcutta, India
McNARY, CAMPBELL	Ingram
PATTERSON, DANIEL TOWNSEND	Pittsburgh
PETERS, CHARLES MEADE	Hamilton, O.
REGAN, FRANK WILLIAM	Cleveland, O.
REITH, AUGUST	Pittsburgh

ROSS, HARRY EARLE	Pittsburgh
ROSE, FLOYD	Bellevue
ROY, UPENDRA NATH	Chittagong, India
RUSHTON, EDWIN E... ..	Wilkinsburg
SEVERANCE, SAMUEL, JR.	Pittsburgh
SIEBERT, CLARENCE STUART	Sewickley
SIMPSON, PAUL LELAND	Monaca
SNURE, JOHN JACOB	Rochester
TAYLOR, DAVID EDWIN	Freeport
WEDD, ALFRED MATHEW	Mt. Lebanon
WEHS, JOSEPH GEORGE	Pittsburgh
WEISBERGER, EDWARD N.	Pittsburgh
WENZ, OTTO FRIEDRICH	Urach, Wurtemberg, Germany
WILLS, WILLIAM HAMAN, JR	Wilkinsburg
WRIGHT, ARTHUR PARK	Pittsburgh
WYNNE, IRA HAROLD	Glenwillard
YOST, RAYMOND GEORGE	Mt. Lebanon
ZIMMERMAN, JAMES ZACHERIAH	Delmont

Total, 72.

Yearly Attendance since the School of Mines was Established.

	1895-6	1896-7	1897-8	1898-9	1899-1900	1900-01
Students	0	5	4	3	5	3
Graduates				0	0	0
	1901-02	1902-03	1903-04	1904-05	1905-06	1906-07
Students	1	4	3	2	9	7
Graduates	1	0	0	0	2	3
	1907-08	1908-09	1909-10	1910-11		
Students	8	34	44	72		
Graduates	1	2	5	18		

Total Graduates, 32.

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University of Pittsburgh

BULLETIN

ANNOUNCEMENT OF THE SCHOOL OF MINES

FOR

1912 - 1913



Entered June 4, 1910, at the Post Office at Pittsburgh, Pa., as second class matter, under Act of Congress of July 16, 1894

University of Pittsburgh

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1140

SCHOOL OF MINES

CALENDAR

1912

- September 26-28 Thursday to Saturday—Entrance Examinations and Registration.
September 30 Monday—Fall Term begins.
November 28-30 Thanksgiving recess, Thursday to Saturday.
December 21 Saturday—Fall Term ends.
Term Vacation from Monday, December 23 to Monday, January 6, 1913.

1913

- January 6 Monday—Winter Term begins.
February 6 Thursday—Day of Prayer for Colleges.
February 22 Saturday—Washington's Birthday, holiday.
March 21 Good Friday, holiday.
March 29 Saturday—Winter Term ends.
March 31 Monday—Spring Vacation of one week begins.
April 7 Monday—Spring Term begins.
June 22 Sunday—Baccalaureate Sermon.
June 25 Wednesday—Commencement.
June 26-28 Thursday to Saturday—Entrance Examinations and Registration.

OFFICES AND OFFICE HOURS

Office, State Hall, Grant Boulevard—Consultation Hours: 8:30 A. M. to 5:30 P. M.

General Office, State Hall; Telephone Schenley 2500.

For catalogues and other information, address the Secretary of the University, Grant Boulevard.

FACULTY

SAMUEL BLACK McCORMICK, D.D., LL.D., CHANCELLOR.

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SAMUEL ALFRED TAYLOR, C.E., Dean.

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HENRY LEIGHTON, A.B., Assistant Professor of Economic Geology.

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JOSEPH ROGER CONRAD, LL.B., Instructor in Mining Economics and Mining Law.

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VICTOR SVIMONOFF, Instructor in Surveying.

SAMUEL BLACK LINHART, D.D., Secretary of the University.

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 RALPH CLEMENT SHUEY, B.S., Instructor in Electro-Metallurgy.
 ROY H. UHLINGER, A.M., Instructor in Gas Analysis.
 Assistant in Practical Mechanics.
 WILLIAM JAMES HEATLEY, Assistant in Practical Mechanics.
 CHARLES SHIVELY MILLER, Physical Director and Director of Athletics.
 KARL JENNINGS HOLLIDAY, Student Assistant in Analytical Chemistry.

LOCATION

STATE HALL, the SCHOOL OF MINES BUILDING, is located at the corner of Grant Boulevard, Bayard Street and Parkman Avenue, opposite the Soldiers' Memorial, and near the Carnegie Institute, including Museum and Library. It is readily accessible from all parts of the city.

SPECIAL ADVANTAGES

The location of Pittsburgh, in the very heart of the bituminous coal fields of the Appalachian system, and in the most richly productive oil fields of Western Pennsylvania, with the great concentration here of mining, metallurgical and ceramic interests, make this undoubtedly one of the most advantageous points in which to study mining, metallurgy and ceramics in the United States.

It is also conveniently located with reference to the bituminous coal fields of Ohio and West Virginia, the anthracite fields of Eastern Pennsylvania, and the Lake Superior iron and copper region.

EQUIPMENT

The buildings of the University are new and embody the latest ideas of design in class-rooms, drafting-rooms, laboratories, etc.

1. THE SMITH CABINET. This collection was formed by the two sisters whose name it bears, and is rich in mineralogical and zoological specimens. Especially is it noteworthy for the size and beauty of the objects from the mineral kingdom.

2. THE MINERALOGICAL LABORATORY is equipped with thousands of specimens and the latest improved apparatus for lecture purposes and the students' laboratory work in crystallography, mineralogy and petrography.

3. THE GEOLOGICAL COLLECTION. A collection showing the ores, coals, clays and building stones as they occur in North America is being acquired, and will be a valuable aid in the study of economic geology.

Besides the special geological collections arranged in the laboratories and lecture-rooms of the School of Mines, the arrangements made through the courtesy of the Director and Trustees of the Carnegie Museum, with part of the staff, afford abundant opportunity for paleontological study.

4. THE FIELD-INSTRUMENT EQUIPMENT includes a large assortment of the various types and makes of instruments used in land surveying, railroad surveying, construction work, leveling, geodetic surveying and mine surveying. The instruction of the student in the care, adjustment and use of the various types of instruments has been kept clearly in mind and well provided for in the selection of equipment.

5. THE MINING LABORATORY is equipped with mine models, miners' picks, shovels; hand drills; breast drills; rock-drills; coal-mining machines; open and safety lamps; instruments for measuring the velocity of air currents; etc.; and it is planned to reopen and completely equip during the coming year, a mine located on the University Campus, near the School of Mines Building.

6. THE ASSAYING AND METALLURGICAL LABORATORIES are equipped with laboratory rock crushers, sieves, assay-balances, etc.; gas and coal-fired muffle furnaces, also with a gas-fired pot furnace, and a regenerative crucible furnace for steel melting experiments is being planned

for. A small cyanide plant has just been installed, capable of treating lots of two hundred pounds of ore by either percolation or agitation methods. The electro-metallurgical equipment is being extended so as to provide opportunity for small scale electrolytic and electric furnace experiments. A chemical laboratory is equipped with all apparatus for the necessary analytical work, and measuring instruments, such as pyrometers, calorimeters, etc. are supplied.

7. THE CERAMIC LABORATORY is equipped with a large jaw crusher, briquette machine for tensile strength tests, vicat needles, a large gas-fired laboratory kiln, a small electric muffle furnace, polarizing microscope, sieves, molds, etc. With some additional equipment soon to be obtained, the laboratory will be prepared to make all necessary physical and chemical tests on clays and to carry on special research work on fire clays, pottery materials, etc.

8. THE CHEMICAL LABORATORIES. These, with the lecture-room, occupy the entire third floor of the Engineering Building. Both lecture-room and laboratories are equipped throughout in the most modern manner. Separate laboratories have been installed in the following branches: Introductory Chemistry and Qualitative Analysis; Quantitative Analysis, with Balance Room in connection; Gas and Fuel Analysis; Water Analysis; Physical and Electro-Chemistry; Spectroscopy; Photography and Research. On the fourth floor there is a special room for preparation and storage of distilled water, which is delivered by gravity to the various laboratories where it is on tap. A spacious store-room permits the distribution of supplies in such a manner that the requirements of the students are promptly met. Machinery for suction and air pressure has been installed and a first-class ventilating system provided so that the air in the laboratories may be pure at all times. The department library is well supplied with works of reference on chemistry for students' use.

9. THE PHYSICAL LABORATORIES. The lecture-room is provided with all the appliances to facilitate a complete course of experimental lectures.

The general physical laboratory is very fully equipped with new apparatus, and is complete in its appointments in every respect. Smaller laboratories are provided for photometry, advanced laboratory practice and research.

A well-equipped shop and mechanician provide excellent facilities for making and repairing apparatus.

The equipment of the department is new and includes an excellent collection of instruments for accurate measurement and investigation.

10. THE MATERIALS TESTING LABORATORY is equipped with machines and instruments for the measurement of the physical properties of the materials of construction, and for tests on manufactured specimens.

There are universal testing machines, ranging from 50,000 lbs. to 200,000 lbs. capacity, for tension, compression, and flexure tests. The 200,000 lbs. capacity machine is capable of taking 15 foot columns, tension specimens accordingly, and flexure specimens up to 20 ft. lengths.

The laboratory also contains a 230,000 inch-pound torsion machine, with a three-inch chucking capacity, and for lengths up to 16 feet; a hand-power flexure machine of 5,000 lbs. capacity; two automatic briquette testing machines, standard molds, scales, sieves, moist closet and other similar apparatus necessary for the examination of cements, cement mortars, and concrete.

11. THE STEAM AND POWER LABORATORY. There is provided the usual equipment for measuring the pressure, temperature, and flow of steam, such as gauges, thermometers, calorimeters, condensers, and indicators, together with suitable apparatus for standardizing and calibrating these.

A Babcock & Wilcox 100 H. P., 200 lb.-pressure boiler, with a super-heating chamber, is used in experimental and power-plant work.

The equipment includes a composite cross-compound steam engine, 7½ and 18 by 14 inches, arranged to run condensing or non-condensing; high-pressure cylinder controlled by single valve; low-pressure cylinder controlled by four Corliss-type valves. The engine is provided with friction brake, which serves for applying loads and for measuring the power delivered at the wheel; and is arranged so that either side may be operated as a simple engine, condensing or non-condensing.

A two-cylinder Westinghouse gas engine, provided with all necessary apparatus for making gas-engine tests is used for experimental purposes. In addition to this, there are located in the laboratory two three-cylinder Westinghouse engines for power purposes.

A motor-driven air-compressor furnishes air for laboratory purposes, and is arranged for use in experimental work.

12. THE DYNAMO LABORATORY. The dynamo-room of the electrical laboratory contains the usual equipment of direct-current and alternating-current motors and generators, and transformers, of different makes and capacities. This includes direct-current generators, constant and variable-speed direct-current motors, single-phase and polyphase induction motors, single-phase series motors, two-phase and three-phase synchronous converters, a. c.-d. c. motor-generator set, and a General Electric mercury-arc rectifier. The laboratory is well equipped with accessory apparatus, such as measuring instruments, brakes, load and starting rheostats, dynamometers, induction regulators, etc. A large floor-crane facilitates the rapid and convenient arrangement of apparatus for the different tests, while a well appointed three-panel switch-board distributes power of the desired kind and voltage to any part of the laboratory.

13. THE HYDRAULIC LABORATORY. For hydraulic experiments there are a Worthington two-stage turbine pump driven by variable-speed motor, a Pelton wheel, and receiving and measuring tanks with weir discharge. There are also water-meters, orifices, nozzles, and a Venturi meter for determining the flow of liquids.

14. PRACTICAL MECHANICS EQUIPMENT. For Pattern-work the equipment consists of wood-working machinery, modern work-benches and tools necessary for pattern-work.

For Foundry-work the equipment consists of the best modern types of melting-furnaces with necessary apparatus for instruction in the principles of molding, core-making, etc.

For Forge-work there are special forges and furnaces, of gas and coal-fired types, including annealing, hardening, and tempering furnaces, a special barium chloride furnace for the treatment of high-speed steels and a 100 pound air hammer.

For Machine-work there are modern belt and motor-driven machines, including screw-cutting lathes, speed lathes, milling machines, planer, shaper, drill-presses, grinding machines, power hacksaw, necessary accessory tools, etc.

15. THE UNITED STATES' EXPERIMENTAL TESTING STATION AND BUREAU OF MINES, for the investigation of mine explosions and other factors relating to mining. Its work is available for the students, who are taught there: First Aid to the Injured, and Mine Rescue Work, receiving certificates therefor from the United States Government, and the United States Red Cross Association.

16. THE LIBRARY. The total number of volumes in the UNIVERSITY LIBRARY is about 7,500. The Reading Room is at present maintained in connection with the Library and is well supplied with the leading scientific periodicals.

THE CARNEGIE LIBRARY, with its immense collection of scientific books and periodicals, is near the School of Mines Building, and all of the files and collections are available for the use of students.

REQUIREMENTS FOR ADMISSION

All candidates for admission to the School of Mines must be at least seventeen years of age and furnish testimonials of good moral character. Those who come from other institutions must present certificates of honorable dismissal.

METHODS OF ADMISSION

I. EXAMINATION. Examinations are held at the University, beginning at 9 o'clock in the morning, on the three days following the Commencement in June, and on the three preceding the opening of the University year in September. For 1912 these dates fall on June 20, 21, and 22, and September 26, 27, and 28.

Certificates of the College Entrance Examination Board and of the New York Regents are accepted in lieu of the entrance examinations at the University.

II. CERTIFICATE FROM ACCREDITED SCHOOLS. Instead of examination, certificates from high schools and academies whose work has been approved by the University as being equivalent to that required for admission to the Freshman class, will be accepted. The official blank provided by the University should be used. It may be obtained upon application to the Registrar or Dean.

III. FROM OTHER COLLEGES. Students from other institutions whose entrance requirements are equivalent to those of the University of Pittsburgh and which offer equivalent courses of study, will be given provisional credit for the work done and admitted to advanced standing without examination. If their work proves satisfactory, the provisional credits will be made permanent.

IV. SPECIAL STUDENTS. Students showing satisfactory evidence of ability, but who are not candidates for a degree, may be admitted without examination to take such work as they are prepared for. This includes students taking irregular or partial courses owing to lack of time to follow the regular course as well as persons of age and experience in practical work who wish to take special courses.

SUBJECTS OF EXAMINATION

For admission to the School of Mines the student who is a candidate for a degree must offer fifteen units, a unit being the equivalent of four recitations per week of one hour each for one year, or five recitations of three-quarters of an hour each.

The units are as follows for 1912:

English, a, 3 units.

Mathematics, a, c, Algebra, $1\frac{1}{2}$ units.

Mathematics, b, d, Plane and Solid Geometry, $1\frac{1}{2}$ units.

History, a, b, c, or d, 1 unit.

German or French, a, b, 2 units. (Spanish may be substituted).

Physics, 1 unit.

Five additional units must be offered from the following subjects:

Chemistry, 1 unit.
Biology, 1 unit.
Drawing, 1 unit.
Physiography, $\frac{1}{2}$ unit.
Shop Work, 1 unit.
Advanced History, 1 unit.
Advanced English, 1 unit.
Latin, a, b, 1 to 2 units.
German, 2 units.
French, 2 units.
Spanish, 2 units.

EXPLANATION OF REQUIREMENTS FOR ADMISSION

English Composition and Literature

a. Three units. The preparation should include the following subjects:

(1) GRAMMAR—It is expected that the applicant will be familiar with the essentials of English grammar, and will be able to explain the construction of sentences that occur in the literature he has read.

(2) COMPOSITION AND RHETORIC—The student should know the elementary principles of rhetoric, and should be able to apply them in the construction of sentences and paragraphs, and in the planning of essays. The examination is chiefly practical, and involves the ability to write good English.

No student will be accepted whose paper is notably deficient in logical development of the subject, or in such details of form as spelling, punctuation, grammar, and division into paragraphs.

(3) LITERATURE—The books recommended are the Uniform College Entrance requirements in English. Other similar works will be accepted as equivalents.

The candidate is required to write one or more paragraphs on each of several subjects chosen from a considerably larger number given in the examination paper. The questions on all of the books assume a knowledge of subject-matter and structure, but those on the books prescribed for study and practice call for more detailed treatment than those on books prescribed for reading.

A—The books prescribed for reading and practice are indicated in the following groups:

Select two sub-divisions from each of the following groups, except when substitution is made from group 2-5, as provided below. Each sub-division is set off by semicolons.

Group 1. The Old Testament, including the most important narrative parts of Genesis, Exodus, Joshua, Judges, Samuel, Kings and Daniel, together with the books of Ruth and Esther; the Odyssey, with the omission of Books I-V, XV-XVII; the Iliad with the omission of Books XI, XIII-XV, XXI; Virgil's *Æneid*. English translations of the Odyssey, the Iliad, and the *Æneid*, of acknowledged literary merit, must be used.

An equivalent amount from Groups 2-5 may be substituted for the two sub-divisions of this group.

Group 2. Shakespeare's *Julius Cæsar*; *The Merchant of Venice*; *As You Like It*; *A Midsummer-Night's Dream*; *Twelfth Night*; *Henry IV*.

Group 3. Goldsmith's *The Vicar of Wakefield*; either Scott's *Ivanhoe* or Scott's *Quentin Durward*; Hawthorne's *The House of the Seven Gables*; Thackeray's *Henry Esmond*; either Dicken's *David Copperfield*, or Dicken's *A Tale of Two Cities*; Mrs. Gaskell's *Cranford*; George Eliot's *Silas Marner*; Stevenson's *Treasure Island*; Defoe's *Robinson Crusoe*, Part I.

Group 4. The de Coverley Papers in *The Spectator*; Franklin's *Autobiography*; Bunyan's *Pilgrim's Progress*, Part I; Irving's *Sketch-Book*; Macaulay's *Essays on Clive and Hastings*; Thackeray's *English Humorists*; selections from Lincoln, including at least the two Inaugurals, the speeches in Independence Hall and at Gettysburg, the *Last Public Address*, and the *Letter to Horace Greely* together with a short memoir or estimate; Parkman's *Oregon Trail*; Thoreau's *Walden*; Huxley's *Autobiography* and selections from *Lay Sermons*, including addresses on *Improving Natural Knowledge*, *A Liberal Education*, and *A Piece of Chalk*; Stevenson's *Inland Voyage* and *Travels With a Donkey*.

Group 5. Palgrave's *Golden Treasury* (First Series), Books II and III, with special attention to Dryden, Collins, Gray, Cowper, and Burns; Gray's *Elegy in a Country Churchyard* and Goldsmith's *The Deserted Village*; Coleridge's *The Ancient Mariner* and Lowell's *The Vision of Sir Launfal*; Scott's *The Lady of the Lake*; Byron's *Childe Harold*, Canto IV, and *The Prisoner of Chillon*; Palgrave's *Golden Treasury*, (First Series), Book IV, with special reference to Wordsworth, Keats, and Shelley; Poe's *The Raven*, Longfellow's *The Courtship of Miles Standish*, and Whittier's *Snow-Bound*; Macaulay's *Lays of Ancient Rome*, and Arnold's *Sohrab and Rustum*; Tennyson's *Gareth and Lynette*, *Lancelot and Elaine*, and *The Passing of Arthur*; Browning's *Cavalier Tunes*, *The Lost Leader*, *How They Brought the Good News from Ghent to Aix*, *Home Thoughts from Abroad*, *Home Thoughts from the Sea*, *Incident of the French Camp*, *Herve Riel*, *Pheidippides*, *My Last Duchess*, *Up at a Villa—Down in the City*.

B—The books prescribed for study and practice are:

Shakespeare's *Macbeth*; Milton's *Lycidas*, *Comus*, *L'Allegro*, and *Il Penseroso*; Burke's *Speech on Conciliation with America*, or Washington's *Farewell Address* and Webster's *First Bunker Hill Oration*; Macaulay's *Life of Johnson* or Carlyle's *Essay on Burns*.

Applicants who are not graduates of accredited high schools, or who have not passed the uniform entrance examinations, will be required to present themselves at the University of Pittsburgh entrance examinations, held the three days preceding the opening of the fall term.

b. One unit.

Advanced standing in English may be given to the graduates of high schools that have exceptionally strong and thorough courses in English thruout the entire four years. This requires additional work in literature and, especially, a thoro knowledge of the elementary principles of rhetoric, and the ability to write good English.

Mathematics

a. ALGEBRA THRU QUADRATICS

One unit. The four fundamental operations for rational algebraic expressions. Factoring, determination of highest common factor and lowest common multiple by factoring. Fractions, including complex fractions, ratio, and proportion. Linear equations, both numerical and literal, containing one or more unknown quantities. Problems depending on linear equations. Radicals, including the extraction of the square root

of polynomials and of numbers. Exponents, including the fractional negative.

Quadratic equations, both numerical and literal. Simple cases of equations with one or more unknown quantities, that can be solved by the methods of linear or quadratic equations. Problems depending on quadratic equations. The binomial theorem for positive integral exponents.

b. PLANE GEOMETRY

One unit. The usual theorems and constructions of the textbooks, including the general properties of plane rectilinear figures; the circle and the measurement of angles; similar polygons; areas, regular polygons and the measurement of the circle. The solution of numerous original exercises. Applications to mensuration.

c. ADVANCED ALGEBRA

One-half unit. Ratio, proportion and variation, variables and limits, properties of series, including the binomial theorem for exponents of all kinds; the progressions; use of undetermined coefficients; permutations and combinations; logarithms, computation and use; summation of recurring series; method of differences; interpolation.

d. SOLID GEOMETRY

One-half unit. The usual theorems and constructions of good textbooks, including the relations of planes and lines in space; the properties and measurements of prisms, pyramids, cylinders, and cones; the sphere and the spherical triangle. The solution of numerous original exercises, including loci problems. Applications to the mensuration of surfaces and solids.

History

One unit each.

a. Ancient history, with special reference to Greek and Roman history, and including also a short introductory study of the more ancient nations and the chief events of the early Middle Ages, down to the death of Charlemagne (814).

b. Mediæval and modern European history, from the death of Charlemagne to the present time.

c. English history.

d. American history and civil government.

Each of the above topics is intended to represent one year of historical work, wherein the study is given five times a week, or two years of historical work, wherein the study is given three times a week.

Latin

One unit each.

a. Grammar and elementary prose composition. A thoro knowledge of all regular inflections, all common irregular forms, the fundamentals of syntax, and a select vocabulary.

b. Cæsar, Gallic War, books I-IV, or the equivalent from other books of the Gallic War or the Civil War, or Nepos' Lives. The examination consists of translation at sight of narrative prose similar to the above.

c. Cicero, the four orations against Catiline and the orations for Archias and for the Manilian Law, or the equivalent from other orations of Cicero or from his letters, or from Sallust's Catiline and Jugurtha, except that the orations for the Manilian Law and for Archias are required. Advanced prose composition. The examination consists of trans-

lation (together with historical, literary, and grammatical questions) partly of passages taken from the two required orations, and partly at sight of passages similar to the above in vocabulary, syntax, and range of ideas. In addition, there is an examination in prose composition.

d. Virgil, *Æneid*, books I-VI, or the equivalent from other books of the *Æneid*, or from the *Bucolics* or *Georgics*, or from Ovid *Metamorphoses*, *Fasti*, or *Tristia*, except that *Æneid* I, II and either IV or VI are required. The examination consists of translation (together with questions on grammar, prosody, literary and historical allusions, and subject-matter) partly of passages taken from the required books, and partly at sight of passages similar to the above in vocabulary, syntax, and range of ideas.

Greek

One or two units.

a. Greek Grammar and the elements, forms, constructions, conditional sentences and indirect discourse, etc. Composition. Translation into Greek of easy Attic prose based on the *Anabasis*.

b. Xenophon's *Anabasis*. Four books, Homer: Books I and II of the *Iliad*.

German

One unit each.

a. ELEMENTARY GERMAN. During the first year the work should comprise (1) careful drill upon pronunciation; (2) the memorizing and frequent repetition of easy colloquial sentences; (3) drill upon the rudiments of grammar; (4) abundant easy exercises designed, not only to fix in mind the forms and principles of grammar, but also to cultivate readiness in the reproduction of natural forms of expression; (5) the reading from 75 to 100 pages of graduated texts from a reader, with constant practice in translating into German easy variations upon sentences selected from the reading lessons.

b. SECOND YEAR GERMAN. During the second year the work should comprise (1) the reading of from 150 to 200 pages of literature in the form of easy stories and plays; (2) practice as before, in the translation into German of easy variation upon the matter read, and also in the reproduction, orally and in writing, of the substance of short and easy selected passages; (3) continued drill upon the rudiments of grammar.

Stories suitable for the elementary course can be selected from the following list: Grimms' *Maerchen*, Gerstaecker's *Germelshausen*, Heyse's *L'Arrabbiata*, Storm's *Immense*, Baumbach's *Der Schwierigersohn*, Schokke's *Der Zerbrochene Krug*, Hillern's *Hoeher als Die Kirche*.

Among shorter plays the best available are perhaps: Benedix's *Der Prozess*, *Der Weiberfreund*; Elz's *Er ist nich eifersuechtig*; Wichert's *An der Majorsecke*; Wilhelm's *Einer mus sheiraten*.

c. THIRD YEAR GERMAN. The work should comprise the reading of about 400 pages of moderately difficult prose and poetry, with constant practice in giving, sometimes orally and sometimes in writing, paraphrases, abstracts, or reproductions from memory of selected portions of the matter read; also grammatical drill upon the less usual strong verbs, the use of articles, cases, auxiliaries of all kinds, tense and modes, and likewise upon word-order and word-formation.

Suitable reading matter for the third year can be selected from such works as the following: Freytag's *Die Journalisten* and *Bilder aus der Deutschen Vergangenheit*—for example. *Karl der Grosse*, *Aus den Kneuz-*

zuegen, Doktor Luther, Aus dem Staat Friedrichs des Grossen, Gerstaecker's Irrfahrten, Hoffman's Historische. Erzaehlungen, Riehl's Der Fluch der Schoenheit, Schiller's Wilhelm Tell, Der Neffe als Onkel, Das Lied von der Glocke, Wilderbruch's Das edle Blut.

French

One unit each.

a. ELEMENTARY FRENCH. In the first year the work should comprise (1) careful drill in pronunciation; (2) the rudiments of grammar; (3) easy composition; (4) the reading of from 150 to 200 duodecimo pages of easy French prose; (5) the writing of French from dictation.

b. SECOND YEAR FRENCH. During the second year the student should read from 300 to 400 pages of easy modern prose. Suitable texts are: Halévy's *L' Abbé Constantin*; Bruno's *Le tour de la France*; Malot's *Sans famille*; Labiche and Martin's *La poudre aux yeux* and *Le voyage de M. Perrichon*; Dumas' *L' Evasion du Duc de Beaufort*. Continued drill upon the rudiments of grammar, the mastery of the chief irregular verbs, dictation, practice in French conversation.

c. THIRD YEAR FRENCH. In the third year from 500 to 600 pages of French of ordinary difficulty should be read. The essentials of French syntax are required, with constant practice in the use of spoken French. Suitable texts are: Daudet's *Contes*; About's *Le Roi des Montagnes*; Merimée's *Colomba*; Augier's *Le Gendre de M. Poirer*; Molière's *Le Bourgeois Gentilhomme*; Maupassant's *Contes*; George Sand's *La Mare au Diable*; Scribe's plays.

Physics

One unit.

The candidate will be expected to be familiar with the fundamental principles of Physics. A sufficiently extended treatment of the subject will be found in any of the principal text-books now in use in secondary schools, such, for instance, as Milliken and Gale, Carhart and Chute, Hoadley, Mann, and Twiss.

It is furthermore very desirable for the student to have received training in laboratory work; but for the present no laboratory work will be required.

Chemistry

One unit. The knowledge gained, if elementary, should be comprehensive and exact, including facts and laws. Laboratory work, emphasizing descriptive chemistry is necessary and notes of this work must be presented. Much attention should be given to solution of problems.

Biology

One unit. Under this one head are grouped the subjects of botany, zoölogy, and physiology. The one unit may be composed of a single subject or of any combination of two. Laboratory exercises or field work equal in time at least to that given to text-book and lecture is essential. In offering subject for credit the names of the text-books used should be given.

Physiography

One-half unit. This subject, otherwise known as physical geography, must have been pursued as a special subject and not as a part of the earlier study of general geography, and a standard text-book, dealing with the subject solely must have been used.

Drawing

One unit. Either free-hand or mechanical drawing, or both, may be offered. Specimens of the work done must be presented, properly certified by the instructor, with a statement of the length of time taken in the course which they represent.

Shop-Work

One unit. The work done must usually have been of the systematic kind prescribed in courses of manual training.

CONDITIONS

No applicant with more than three entrance conditions will be admitted as a regular student. Conditions must be partly removed before the second year, and wholly before the third.

SCHOLARSHIPS

Five scholarships are offered in the School of Mines. These scholarships entitle the holders to free tuition, and are to be awarded to the sons of men engaged in mining. One of these scholarships is limited to residents of Allegheny County; the others are available to those residing in Western Pennsylvania.

TUITION AND FEES

The tuition covers all fees except those specially mentioned below, and must be paid, with all current fees, upon registration, before name can be entered on class rolls.

Matriculation Fee (at entrance only)	\$	5.00
Tuition, Fall Term		40.00
Tuition, Other Terms		35.00
Tuition per year, if paid in advance (except Freshman Year).....		105.00
Tuition, Freshman year (four terms), if paid in advance.....		140.00
Chemistry, each course	Per Term	5.00
Shop	" "	5.00
Engineering Laboratory	" "	5.00
Assaying, (Fire)	" "	10.00
Metallurgical Laboratory	Fall Term	5.00
.....	Winter and Spring Term, each	10.00
Mineralogical Laboratory	Per Term	3.00
Surveying (Summer Course)		10.00
Special Laboratory Work.....	Fees by arrangement	
Saturday Courses	Per Term	5.00
Spring Trip, Junior Year, Three Weeks.....	Estimated	75.00
Breakage Deposit for all students taking laboratory work		10.00
(Any balance remaining will be returned.)		
Diploma		5.00

DEGREES

The degrees conferred upon those satisfactorily completing courses offered are, respectively:

Engineer of Mines (E. M.), Metallurgical Engineer (Met. E.), Geological Engineer (Geol. E.), Ceramic Engineer (Cer. E.).

COURSES IN THE SCHOOL OF MINES

In order to retain the advantages of the elective system, whereby the student may choose his work along the line for which he seems best fitted, and at the same time to be certain that every man shall have a well-rounded course, the following group system has been adopted for regular undergraduate students.

The first two years' work is common to all courses. At the beginning of the third year, the student elects between Mining, Metallurgy, Geology and Ceramics, although there is little difference for the first two terms of that year; at the beginning of the spring term of the third year, there is further choice between metal-mining and coal-mining, and between general metallurgy and the metallurgy of iron and steel. The work of the fourth or Senior year is, of course, quite different in the different groups.

COURSE IN MANAGEMENT

Recognizing that, in a four-years' course in mining, metallurgy or ceramics, the student cannot expect to get more than the fundamentals of the profession; and further, that there is need for men trained along managerial lines, a fifth or post-graduate year is offered, leading to the degree of Master of Science, with the idea that men taking this course will be fitted for work as executives.

Each application for admission to the course in Management will be decided upon its own merits. In general, however, graduation from a recognized technical school, supplemented by at least one year's practical work, will be necessary for admission.

A further description of this course will be found on page 27.

SHORT COURSES

The following short courses have been arranged for practical men who cannot afford the time to take a regular course:

1. For practical miners who desire to prepare for examination for fire-bosses;
2. For fire-bosses who wish to secure a mine foreman's certificate;
3. For those desiring to prepare for the mine inspector's examination;
4. For mine electricians.

Further description will be found on page 27.

Those who satisfactorily complete any of these courses will receive certificates of proficiency.

Similar short courses can be arranged in Metallurgy and Ceramics at any time that a sufficient number of applications are received.

OUTLINE OF COURSES

Group I—Mining. Leads to degree of Engineer of Mines.

Group II—Metallurgy. Leads to degree of Metallurgical Engineer.

Group III—Geology. Leads to degree of Geological Engineer.

Group IV.—Ceramics. Leads to degree of Ceramic Engineer.

FRESHMAN YEAR

REQUIRED IN GROUPS I, II, III, IV.

FALL TERM

No.	Subject	Class	Lab.	Credits	See Page
Math. 5	Plane Trigonometry	3	0	3	30
Math. 6	Advanced Algebra	2	0	2	30
Chem. 1 (or 3)	Inorganic Chemistry	2	6	4	31
Gr. 1	Mechanical Drawing	0	3	1	32
P. Mech. 1	Frame Work & Patterns	1	6	3	33
En. 1	English Composition	3	0	3	28
Pub. Sp. 1	Public Speaking	1	0	1	28
Ger. or Rom.	German, French or Spanish	3	0	3	29
		15	15	20	

WINTER TERM

Math. 7	Analytic Geometry	5	0	5	30
Chem. 2 (or 4)	Inorganic Chemistry	2	6	4	31
Gr. 2	Mechanical Drawing	0	3	1	32
P. Mech. 2	Foundry Work	1	6	3	33
En. 2	English Composition	3	0	3	28
Pub. Sp. 2	Public Speaking	1	0	1	28
Ger. or Rom.	German, French or Spanish	3	0	3	29
		15	15	20	

SPRING TERM

Math. 4	Spherical Trigonometry	2	0	2	30
Math. 8	Analytic Geometry	5	0	5	30
Chem. 8	Qualitative Analysis	2	6	4	31
Gr. 3	Mechanical Drawing	0	6	2	32
P. Mech. 3	Forge Work	1	6	3	33
En. 3	English Composition	3	0	3	28
Ger. or Rom.	German, French or Spanish	3	0	3	29
		16	18	22	

SUMMER TERM

C. E. 22	Surveying—50 hours per week for 10 weeks—20 credits. (See page 34).
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SOPHOMORE YEAR

REQUIRED IN GROUPS I, II, III, IV.

FALL TERM

No.	Subject	Class	Lab.	Credits	See Page
Math. 9	Calculus	4	0	4	30
Chem. 9	Quantitative Analysis	1	6	3	31
Phys. 11	Physics	4	3	5	31
Gr. 4	Mech. Sketching & Drafting	0	6	2	32
P. Mech. 4	Machine Work in Metals	1	3	2	34
Geol. 1	General Geology	3	0	3	37
Miner. 2	Crystallography and Mineralogy	1	6	3	37
		14	24	22	

WINTER TERM

Math. 10	Calculus	4	0	4	30
Chem. 10	Quantitative Analysis	1	6	3	31
Phys. 12	Physics	4	3	5	31
Gr. 5	Descriptive Geometry	2	6	4	32
Geol. 2	Stratigraphical Geology	3	0	3	38
Miner. 3	Mineralogy	1	6	3	37
		15	21	22	

SPRING TERM

Chem. 11	Quantitative Analysis	1	6	3	31
Phys. 13	Physics	4	3	5	31
Mech. 1	Analytic Mechanics	5	0	5	32
Geol. 3	Structural & Field Geology	3	6	5	38
Miner. 4	Mineralogy & Lithology	1	6	3	37
		14	21	21	

JUNIOR YEAR, GROUP I.

FALL TERM

No.	Subject	Class	Lab.	Credits	See Page
Mech. 2	Mechanics of Materials	5	0	5	32
Mech. 3	Mechanical Laboratory	0	6	2	33
Mech. 4	Graphic Statics	1	6	3	33
Ec. Geol. 1	Economic Geology	3	0	3	38
Mine 1	Principles of Mining	3	0	3	39
Met. 1	Principles of Metallurgy	3	3	4	43
Met. 4	Ore Dressing	3	0	3	43
		18	15	23	

WINTER TERM

E. E. 2	Dynamos and Motors	2	3	3	35
M. E. 4	Prime Movers	2	3	3	35
Ec. Geol. 2	Economic Geology	3	0	3	38
Mine 2	Principles of Mining	3	0	3	39
Mine 11	Underground Surveying	2	3	3	40
Met. 2	Principles of Metallurgy	3	6	5	43
Met. 5	Ore Dressing	3	0	3	43
		18	15	23	

SPRING TERM

Mech. 5	Hydro-Mechanics & Hydraulics	4	0	4	33
Mech. 6	Hydraulic Laboratory	0	3	1	33
Ec. Geol. 3	Economic Geology	3	0	3	38
Mine 3	Ore-Mining Methods	3	0	3	*40
Mine 4	Coal-Mining Methods	2	0	2	†40
Mine 5	Mine-Gases and Explosions	3	0	3	†40
Mine 26	Inspection Trips	0	6	2	42
Met. 3	Principles of Metallurgy	3	6	5	43
Met. 6	Ore-Dressing (Stamp-Milling)	3	0	3	*43
Met. 23	Ore-Dressing (Coal-Washing)	3	0	3	†44
		16	15	21	*
		18	15	23	†

*Metal-Mining Option.

†Coal-Mining Option.

Trip—3 weeks Spring Vacation. (See page 46.)

SENIOR YEAR, GROUP I.

FALL TERM

No.	Subject	Class	Lab.	Credits	See Page
C. E. 23	Masonry, Concrete, etc.	3	6	5	35
Mine 18	Mine Economics	3	0	3	41
Mine 23	Seminar	1	0	1	42
Met. 24	Assaying	1	6	3	44
	Electives in Mining*			5	
	Other Electives			5	
				22	

WINTER TERM

Mine 9	Power Transmission in Mines	2	0	2	40
Mine 12	Mine Plant Design	1	6	3	41
Mine 19	Mine Economics	3	0	3	41
Mine 21	Mining Law	2	0	2	41
Mine 24	Seminar	1	0	1	42
	Electives in Mining†			5	
	Other Electives			6	
				22	

SPRING TERM

Ec. 46	Contracts and Specifications	3	0	3	36
Mine 13	Mine Plant Design	1	6	3	41
Mine 15	First Aid and Mine Rescue Work	0	6	2	41
Mine 20	Mine Valuation	2	0	2	41
Mine 22	Mining Law	2	0	2	41
Mine 25	Seminar	1	0	1	42
	Electives in Mining‡			4	
	Other Electives			5	
				22	

*Those taking Coal Option must elect Mine 6, Mine Gas Analysis.

†Those taking Coal Option must elect Mine 7, Ventilation.

‡Those taking Coal Option must elect Mine 14, Projection of Mine Workings.

JUNIOR YEAR, GROUP II.

FALL TERM

No.	Subject	Class	Lab.	Credits	See Page
Chem. 51	Advanced Inorganic Chemistry,	2	0	2	31
Mech. 2	Mechanics of Materials,	5	0	5	32
Mech. 3	Mechanical Laboratory,	0	6	2	33
Mech. 4	Graphic Statics,	1	6	3	33
Mine 1	Principles of Mining,	3	0	3	39
Met. 1	Principles of Metallurgy	3	6	5	43
Met. 4	Ore Dressing	3	0	3	43
		17	18	23	

WINTER TERM

Chem. 52	Advanced Inorganic Chemistry	2	0	2	31
E. E. 2	Dynamos and Motors	2	3	3	35
M. E. 4	Prime Movers	2	3	3	35
Mine 2	Principles of Mining	3	0	3	39
Met. 3	Principles of Metallurgy	3	6	5	43
Met. 5	Ore Dressing	3	0	3	43
		15	12	19	

SPRING TERM

Chem. 53	Advanced Inorganic Chemistry,	2	0	2	31
Mech. 5	Hydromechanics and Hydraulics	4	0	4	33
Mech. 6	Hydraulic Laboratory	0	3	1	33
Mine 3	Ore-Mining Methods	3	0	3	40
Mine 26	Inspection Trips	0	6	2	42
Met. 3	Principles of Metallurgy	3	6	5	43
Met. 6 or 23	Ore Dressing	3	0	3	43
		15	15	20	

Trip—3 weeks Spring Vacation. (See page 46).

SENIOR YEAR, GROUP II.

FALL TERM

No.	Subject	Class	Lab.	Credits	See Page
Met. 7	Principles of Metallurgy	1	6	3	43
Met. 16	Metallurgy of Copper, Lead, the				
	Minor Metals	4	0	4*	44
Met. 13	Metallurgy of Iron and Steel	4	0	4†	43
Met. 24	Assaying	1	6	3	44
Met. 34	Current Literature	1	0	1	45
	Electives in Metallurgy			5	
	Other Electives			6	
				22	

WINTER TERM

Met. 8	Principles of Metallurgy	3	0	3	43
Met. 17	Metallurgy of Copper, Lead, the				
	Minor Metals	4	0	4*	44
Met. 14	Metallurgy of Iron and Steel	4	6	6†	43
Met. 25	Assaying	0	6	2*	44
Met. 35	Current Literature	1	0	1	45
	Electives in Metallurgy			6	
	Other Electives			6	
				22	

SPRING TERM

Ec. 46	Contracts and Specifications	3	0	3	36
Met. 9	Principles of Metallurgy	3	0	3	43
Met. 18	Metallurgy of Copper, Lead, the				
	Minor Metals	4	0	4*	44
Met. 15	Metallurgy of Iron and Steel	4	0	4†	43
Met. 36	Current Literature	1	0	1	45
	Electives			11	
				22	

*Required in General Metallurgy Option only.

†Required in Iron Option only.

JUNIOR YEAR, GROUP III.

FALL TERM

No.	Subject	Class	Lab.	Credits	See Page
Mech. 2	Mechanics of Materials	5	0	5	32
Mech. 3	Mechanical Laboratory	0	6	2	33
Mech. 4	Graphic Statics	1	6	3	33
Ec. Geol. 1	Economic Geology	3	0	3	38
Min. 7	Petrography	1	6	3	37
Mine 1	Principles of Mining	3	0	3	39
Met. 1	Principles of Metallurgy	3	3	4	43
		16	21	23	

WINTER TERM

Ec. Geol. 2	Economic Geology	3	0	3	38
Min. 8	Petrography	1	6	3	37
Mine 2	Principles of Mining	3	0	3	39
Mine 11	Underground Surveying	2	3	3	40
Met. 2	Principles of Metallurgy	3	6	5	43
		12	15	17	

SPRING TERM

Mech. 5	Hydro-Mechanics and Hydraulics	4	0	4	33
Mech. 6	Hydraulic Laboratory	0	3	1	33
Ec. Geol. 3	Economic Geology	3	0	3	38
Min. 9	Petrography	1	6	3	37
Mine 3	Principles of Mining	3	0	3	40
Mine 26	Inspection Trips	0	6	2	42
Met. 3	Principles of Metallurgy	3	3	4	43
		14	18	20	

Trip—3 weeks Spring Vacation. (See page 46).

SENIOR YEAR, GROUP III.

FALL TERM

No.	Subject	Class	Lab.	Credits	See Page
Geol. 4	Invertebrate Paleontology	2	6	4	38
Ec. Geol. 10	Seminar	1	0	1	38
Mine 10	Placer Mining	2	0	2	40
	Electives in Economic Geology			7	
	Other Electives			8	
				22	

WINTER TERM

Geol. 5	Invertebrate Paleontology	2	6	4	38
Ec. Geol. 11	Seminar	1	0	1	38
Mine 27	Mining for Petroleum	2	0	2	42
Mine 21	Mining Law	2	0	2	41
	Electives in Economic Geology			6	
	Other Electives			7	
				22	

SPRING TERM

Geol. 6	Invertebrate Paleontology	2	6	4	38
Ec. Geol. 12	Seminar	1	0	1	38
Mine 28	Mining for Petroleum, etc.	2	0	2	42
Mine 22	Mining Law	2	0	2	41
Mine 20	Mine Valuation	2	0	2	41
	Electives in Economic Geology			5	
	Other Electives			6	
				22	

JUNIOR YEAR, GROUP IV.

FALL TERM

Chem. 12	Advanced Quantitative Analysis	1	6	3	31
Mech. 2	Mechanics of Materials	5	0	5	32
Mech. 3	Mechanical Laboratory	0	6	2	33
Mech. 4	Graphic Statics	1	6	3	33
Ec. Geol. 1	Economic Geology	3	0	3	38
Mine 1	Principles of Mining	3	0	3	39
Cer. 1	Investigation & Testing of Clays	1	6	3	45
Cer. 4	Manufacture of Clay Products	2	0	2	45
		16	24	24	

WINTER TERM

Chem. 13	Advanced Quantitative Analysis	1	6	3	31
E. E. 2	Dynamos and Motors	2	3	3	35
M. E. 4	Prime Movers	2	3	3	35
Ec. Geol. 2	Economic Geology	3	0	3	38
Mine 2	Principles of Mining	3	0	3	39
Cer. 2	Investigation and Testing of Clays	1	6	3	45
Cer. 5	Manufacture of Clay Products	2	0	2	45
		14	18	20	

SPRING TERM

Chem. 14	Advanced Quantitative Analysis	1	6	3	31
Mech. 5	Hydromechanics and Hydraulics	4	0	4	33
Mech. 6	Hydraulic Laboratory	0	3	1	33
Ec. Geol. 3	Economic Geology	3	0	3	38
Mine 4	Coal-Mining Methods	2	0	2	40
Cer. 3	Investigation and Testing of Clays	1	6	3	45
Cer. 6	Manufacture of Clay Products	2	0	2	45
Cer. 9	Inspection Trips	0	6	2	45
		13	21	20	

Trip—3 weeks Spring Vacation. (See page 46).

SENIOR YEAR, GROUP IV.

FALL TERM

Met. 1	Principles of Metallurgy	3	3	4	43
Cer. 10	Pottery and Glazes	2	0	2	45
Cer. 13	Ceramic Laboratory	0	15	5	46
Cer. 17	Seminar	1	0	1	46
Cer. 20	Plant Design	1	6	3	46
	Electives			7	

22

WINTER TERM

Met. 2	Principles of Metallurgy	3	3	4	43
Cer. 11	Pottery and Glazes	2	0	2	45
Cer. 14	Ceramic Laboratory	0	15	5	46
Cer. 18	Seminar	1	0	1	46
Cer. 21	Plant Design	1	6	3	46
	Electives			7	

22

SPRING TERM

Ec. 46	Contracts and Specifications	3	0	3	36
Met. 3	Principles of Metallurgy	3	3	4	43
Cer. 12	Pottery and Glazes	2	0	2	45
Cer. 15	Ceramic Laboratory	0	15	5	46
Cer. 19	Seminar	1	0	1	46
	Electives			7	

22

POST-GRADUATE YEAR

(See page 15 for announcement.)

In this course the individual student will, necessarily, be allowed some latitude in his choice of work, depending upon his training and experience, and depending also upon whether he wishes to confine his investigation work to mines or mills of the types found in this district, or to work further afield.

In the fall term the class-room work will be mainly in elementary psychology, sociology and economics, and the theory of management, considerable time being allowed the student to study conditions and systems in the mines and mills of the Pittsburgh region.

The winter term is spent entirely in the field, each man being given an outline of work to follow, so that he may be able to ascertain what are the difficulties which confront the average superintendent or manager, and how these are met. He is required to make a weekly report to the school, in order that his work may be closely followed up and proper suggestions made to him.

At the beginning of the spring term he returns to the school, where he takes more advanced economics, etc., and works up into proper shape for presentation the data gathered during the fall and winter terms.

As indicated above, this schedule is variable, the endeavor being to fit the course to the individual student, rather than the student to the course. Those interested should write to the Dean for further information.

SHORT COURSES

(See page 15 for announcement.)

1. Course arranged for men desirous of a fire-boss' certificate includes the following subjects:

Mine Ventilation,
Mining Law,
Mine Gases and Explosions,
Mine Accidents and their Prevention.

2. Course arranged for men desirous of a foreman's certificate includes the following subjects:

Methods of Working,
Mine Drainage and Pumps,
Haulage and Hoisting,
Recovering Coal Mines after Explosions and Fires.

3. Course arranged for men desirous of a State Mine Inspector's certificate includes the following subjects:

Engines and Boilers,
Principles of Chemistry,
Elementary Electricity,
Mine Economics or
Compressed Air in Mining.

4. Course arranged for men desirous of a position as mine electrician includes the following subjects:

Electricity in Mines,
Elementary Electricity,
Engines and Boilers,
Mine Gases and Explosions or
Mine Accidents and their Prevention.

The idea in arranging these courses is that men may take them in their proper order. For instance, one who has taken Course No. 1 may

continue by taking Course No. 2 and upon its completion Course No. 3, thus in two years' time fitting himself as an applicant for a State Mine Inspectorship. Course No. 4 is arranged solely for men desiring a theoretical, as well as a practical, knowledge of electricity.

Saturday afternoons throughout the scholastic year have been set aside for the purpose of meeting men entering upon any of these four courses. This day has been selected as it offers better opportunity for men to leave their work at the mine and reach the city. With this arrangement one week's time is given to the preparation of the work, and Saturday afternoon devoted to recitations and explanations.

Wherever the applicant for any course wishes to substitute a subject from another course, permission may be had by presenting the matter in writing to the Dean of the School.

DEPARTMENTS OF INSTRUCTION

The following include the required courses in the School of Mines, together with such electives as it was thought might be chosen by students of the School. For further studies which are open as electives see the general catalog of the University.

English Language and Literature

1, 2, 3. RHETORIC AND COMPOSITION

Mr. Fall, Winter and Spring Terms, each 3 credits.

A study of the principles of composition, with exercises in the analysis of prose selections, practice in writing, and criticism.

Required of all Freshmen.

7. ARGUMENTATION AND DEBATING

Professor Gibbs and Mr. Fall and Winter Terms, each 3 credits.

The theory of argumentation, with practical exercises in brief-drawing and the composition and the delivery of forensics.

Elective for students who have taken Courses 1, 2, 3, or 4, 5, 6.

15. ENGLISH LITERATURE

Professor Gibbs.

Winter Term, 3 credits.

A study of selected masterpieces representing the successive periods of English literature, with a text-book to furnish a historical background and connections.

Elective for students who have taken Courses 1, 2, 3, or 4, 5, 6.

1, 2. PUBLIC SPEAKING

Mr. Fall and Winter Terms, 2 credits.

Exercises in the fundamentals of public address. Individual instruction in small classes.

Required of all Freshmen.

4, 5, 6. PUBLIC SPEAKING

Mr. Fall, Winter and Spring Terms, each 3 credits.

An advanced course in expression, both spoken and written. Students are encouraged to develop individuality and readiness in the expression of thought.

Elective for students who have taken Courses 1, 2.

German Language and Literature

1, 2, 3. ELEMENTARY GERMAN

Professor Berger. Fall, Winter and Spring Terms, 3 credits each term.

Elements of grammar and the reading of easy texts. Vos, *Essentials of German*; Hewitt's *German Reader*; Simple lyrics and ballads memorized. Gerstaecker, *Germelhausen*; Baumbach, *Der Schwiegersohn*.

Open to Freshmen who have satisfied requirements for admission by offering French or Latin if they wish to take up German as the required modern language.

4, 5, 6. INTERMEDIATE COURSE

Professor Berger. Fall, Winter and Spring Terms, 3 credits each term.

Review of Grammar. Drill in translating from English into German and practice in conversation. Memorizing of simple prose and poetry. Wesselhoeft: *German Exercises*. Wenckebach: *German Composition*. Wildenburch: *Des edle Blut*. Gerstaecker: *Irrfahrten*. Hatfield: *German Lyrics and Ballads*.

Classical German Authors. Selections from the following lists of texts: Schiller: *Maria Stuart*. Goethe: *Hermann und Dorothea*. Lessing: *Minna von Barnhelm*. German is used extensively in conducting class work.

Required of all Freshmen satisfying entrance requirements in German who elect to continue it.

7, 8, 9. TECHNICAL GERMAN

Fall, Winter and Spring Terms, 3 credits each term.

Syntax. Prose Composition, conversation. Freytag: *Soll und Haben*, *Aus dem Jahrhundert des grossen Krieges*. Whitefield and Kaiser: *A Course of Commercial German*.

Elective for students who have taken previous courses.

Romance Languages and Literatures

1, 2, 3. ELEMENTARY FRENCH

Professor Harry. Fall, Winter and Spring Terms, 3 credits each term.

Grammar, composition and easy reading, with thorough drill in pronunciation and practice in speaking.

Open to Freshmen who have satisfied requirements for admission by offering German or Latin, if they wish to pursue French as the required modern language.

4, 5, 6. INTERMEDIATE FRENCH

Professor Harry. Fall, Winter and Spring Terms, 3 credits each term.

Extensive reading in selected works of Modern French writers. Fraser and Squair's Grammar completed. Advanced prose composition. French conversation. The following texts are read: Daudet, *Contes Choisis*; Maupassant, *Contes*; Coppee, *On rend l'Argent*; Augier, *Le Gendre de M. Poirer*; George Sand, *La Mare au Diable*; Canfield; French Lyrics.

Required of all Freshmen satisfying entrance requirements in French who elect to continue it.

7, 8, 9. TECHNICAL FRENCH

Professor Harry. Fall, Winter and Spring Terms, 3 credits each term.

Herdler's *Scientific Reader* and other works of similar character will be read. The purpose of this course is to enable students to use Scientific French readily and is primarily designed for students in Engineering courses who have a good reading knowledge of ordinary French prose.

30, 31, 32. ELEMENTARY SPANISH

Fall, Winter and Spring Terms, 3 credits each term.

Hill's and Ford's *Spanish Grammar*, reading, composition, conversation. Bransby's *Spanish Reader*, Selgas, *La Mariposa Blanca*; Galdos, *Dona Perfecta*; Tamayo, *Lo Positivo*; Giese's *Spanish Anecdotes*.

35, 36, 37. COMMERCIAL SPANISH

Fall, Winter and Spring Terms, 3 credits each term.

Reading of Commercial Spanish. Commercial correspondence. Conversation. The vocabulary of every day life is emphasized.

40, 41, 42. ELEMENTARY ITALIAN

Fall, Winter and Spring Terms, 3 credits each term.

Elementary grammar, dictation, reading, memorizing, conversation, and easy composition. Motti's *Elementary Italian Grammar*. Cattaneo, *Italian Reader*. DeAmicis, *Cuore*. Other selections from modern authors will be assigned by the instructor.

43, 44, 45. ITALIAN, INTERMEDIATE COURSE

Fall, Winter and Spring Terms, 3 credits each term.

Study of the Italian Grammar in Italian. Conversation and advanced prose composition. Italian literature of the XVIII and XIX centuries. Selected readings and brief lectures in Italian. Manzoni, *I Promessi Sposi*, will be read in full.

Open to students who have taken the course in Elementary Italian.

Mathematics

4. SPHERICAL TRIGONOMETRY

Professor Frost.

Spring Term, 2 credits.

Theory and application to solution of right and oblique spherical triangles.

Required of all Freshmen.

5. PLANE TRIGONOMETRY

Mr. Dyche and Mr. Albert.

Fall Term, 3 credits.

The subjects treated are the functions of angles, goniometry, trigonometric equations, solution of right and oblique triangles, Special emphasis is placed upon solution of examples of all kinds involving both theory and practical applications.

Required of all Freshmen.

6, 7, 8, 9, 10.

Dr. Wenrich, Mr. Dyche and Mr. Albert.

Freshman Year:

Fall Term, 2 credits; Winter Term, 5 credits; Spring Term, 5 credits.

Sophomore Year:

Fall Term, 4 credits; Winter Term, 4 credits.

This is a course in Mathematics for students in Engineering and Applied Science as presented in Woods and Bailey's Text.

Advanced Algebra, Analytic Geometry, Differential and Integral Calculus are combined in this one Treatise.

The course extends throughout the Freshman year and terminates at the end of the second term in the Sophomore year.

Required in all Groups.

Chemistry

1, 2. GENERAL INORGANIC CHEMISTRY

Dr. Vogt, and Assistants. Fall and Winter Terms, 4 credits each term.

Two lectures or recitations and six laboratory hours each term. This course includes lectures and recitations upon the chemistry of the non-metals and metals. It forms an introduction to the study of chemistry and serves as a foundation for subsequent work in this department. The laboratory work includes experiments in further illustration of the subject.

Required of all Freshmen.

8. QUALITATIVE ANALYSIS

Professor Silverman and Assistants.

Spring Term, 4 credits.

This course consists of two lectures and recitations and six laboratory hours a week. The work includes the study of the reactions of bases and acids and the analysis of simple compounds and mixtures.

Pre-requisites: Courses 1, 2 or 3, 4.

Required of all Freshmen.

9, 10, 11. QUANTITATIVE ANALYSIS

Professor Silverman and Mr. Pratt.

Fall, Winter and Spring Terms, 3 credits each term.

This course consists of one lecture and six laboratory hours weekly, and includes a general study of the simpler methods for the determination of the commonly occurring elements and radicals, and also the complete analysis of various minerals.

Pre-requisite: Course 8.

Required of all Sophomores.

12, 13, 14. ADVANCED QUANTITATIVE ANALYSIS

Professor Silverman and Mr. Shively.

Fall, Winter and Spring Terms, 3 credits each term.

For the completion of this course one lecture and six laboratory hours a week are required. The work includes complete analysis of minerals, ores, iron and steel, cements and alloys.

Pre-requisites: Courses 9-11.

Required in Group IV.

51, 52, 53. ADVANCED INORGANIC CHEMISTRY

Dr. Vogt.

Fall, Winter and Spring Terms, 2 credits each term.

This course supplements the work in the Elementary course in Chemistry and deals especially with the modern theories of chemistry. Two lectures per week.

Pre-requisite: Chemistry 8.

Required in Group II.

Physics

11, 12, 13. GENERAL PHYSICS

Professor Bishop and Mr. Morris.

Fall, Winter and Spring Terms, 5 credits each term.

First term, mechanics and heat; second term, electricity; third term, sound and light. In this course the calculus is extensively employed and special attention is given to the physical interpretation of mathematical equations.

A series of twelve lectures on the precision of measurements is given in connection with the laboratory work. Special attention is given in the laboratory to the method of the experiment and to the precision of the results.

Concurrent with Mathematics 8 and 10.

Required of all Sophomores.

Graphics

1. MECHANICAL DRAWING

Mr. Lambie.

Fall Term, 1 credit.

The care and use of drafting instruments, instrument exercises, geometrical constructions, lettering, shading, exercises in drawing to scale, and dimensioning.

Three hours per week in drafting room. Freshman Year.

2. MECHANICAL DRAWING

Mr. Lambie.

Winter Term, 1 credit.

Orthographic projections, rotation of objects, oblique projections, intersections, and development of surfaces.

Three hours per week in drafting room. Freshman year.

Pre-requisite: Graphics 1.

3. MECHANICAL DRAWING

Mr. Lambie.

Spring Term, 2 credits.

Isometric drawing and dimensioning, sectioning, and machine drawing. Six hours per week in drafting room. Freshman year.

Pre-requisite: Graphics 2.

4. MECHANICAL SKETCHING AND DRAFTING

Mr. Lambie.

Fall Term, 2 credits.

Graded exercises in the measuring and sketching of mechanical constructions, and the subsequent detail drafting of the same.

Six hours per week in drafting room. Sophomore year.

Pre-requisite: Graphics 3.

5. DESCRIPTIVE GEOMETRY

Mr. Lambie.

Winter Term, 4 credits.

A critical study of the science of representing by drawing. The location of points, lines, planes, single curved surfaces, surfaces of revolution, and warped surfaces, with their relations to each other; tangent lines and planes; intersection of surfaces; shades, shadows, and perspective.

Two lectures and six hours in drafting room per week. Sophomore year.

Pre-requisites: Graphics 4; Mathematics 7.

Mechanics

1. ANALYTIC MECHANICS

Professor Frost.

Spring Term, 5 credits.

This subject comprises among its topics the composition and resolution of forces, the center of gravity, the moment of inertia, radius of gyration, laws of friction and of motion, projectiles, impact, machines, work, and energy. The solution of numerous problems in application of formulas is constantly required.

Five recitations and lectures per week. Sophomore year.

Pre-requisite: Mathematics 10.

2. MECHANICS OF MATERIALS

Mr. Lambie.

Fall Term, 5 credits.

The resistance and elasticity of materials. The action of beams under various conditions of fixity and loading; strength of columns and shafts; combined stresses; resilience of materials; etc.

Five recitations and lectures per week. Junior year.

Pre-requisite: Mechanics 1.

3. MECHANICAL LABORATORY

Mr. Richardson.

Fall Term, 2 credits.

The experimental study of the physical properties of the materials of construction, such as iron and steel, wood, brick, stone, cement, and concrete.

Six laboratory-hours per week. Junior year.

To be taken concurrently with Mechanics 2.

4. GRAPHIC STATICS

Mr. Bankson.

Fall Term, 3 credits.

The solution of problems in which the stresses in frame work, beams, roof and bridge trusses are ascertained by graphical methods. Methods for dead, snow, wind, and live loads.

One lecture and six hours drawing per week. Junior year.

Pre-requisites: Graphics 1; Mechanics 1.

5. HYDRO-MECHANICS AND HYDRAULICS

Mr. Richardson.

Spring Term, 4 credits.

The equilibrium and pressure of liquids; the motion and work of fluids; the flow of water through orifices, over weirs, in pipes, and in canals; measurements of water power; and hydraulic machinery.

Four recitations and lectures per week. Junior year.

Pre-requisites: Mechanics 1; Mathematics 10.

6. HYDRAULIC LABORATORY

Mr. Richardson.

Spring Term, 1 credit.

The experimental study of the flow of water through pipes, nozzles, and orifices, and over weirs. Capacity and efficiency tests of hydraulic turbine pumps and motors.

Three laboratory hours per week. Junior year.

To be taken concurrently with Mechanics 5.

Practical Mechanics

1. FRAME WORK AND PATTERN MAKING

Mr. Weber and Mr. Heatley.

Fall Term, 3 credits.

Lectures are given on the use of wood-working tools, and the laying out and construction of frame work, templets, patterns and core-boxes. The student is required to execute in the University Shops a graded set of exercises in the construction of simple frame-work, patterns, and core boxes. Inspection trips, on which written reports are required, are taken during shop hours when deemed advantageous.

One lecture and six shop hours per week. Freshman year.

2. FOUNDRY WORK

Mr. Weber and Mr. Heatley.

Winter Term, 3 credits.

Lectures are given on the principles and practice of moulding and founding of metals. The student is required to execute in the University Shops a graded set of exercises in moulding and core making, together with the melting and casting of metals. Frequent inspection trips, on which written reports are required, are taken during shop hours to local foundries. Freshman year.

3. FORGE WORK

Mr. Weber and Mr.....

Spring Term, 3 credits.

Lectures are given on the principles and practice of forging and the heat treatment of metals. The student is required to execute in the University Shops a series of exercises in the forging, welding, riveting,

and case-hardening of soft steel and iron; and the forging and heat treatment of the various grades of tool steel. Inspection trips, on which written reports are required, are taken during shop hours when deemed advantageous.

One lecture and six shop hours per week. Freshman year.

4. MACHINE WORK IN METALS

Mr. Weber.

Fall Term, 2 credits.

Lectures are given on modern machine tools and machine shop practice. The student is required to execute in the University Shop a graded set of exercises in making measurements; and in the use of lathes, planers, shapers, milling machines, grinders, etc.; and in the assembling of machine parts. Frequent inspection trips, on which written reports are required, are taken during shop hours to local machine shops.

One lecture and three shop hours per week. Sophomore year.

Civil Engineering

22. SURVEYING

Mr. SVIMONOFF

Summer Term, 20 credits.

The course includes

I. PRELIMINARY SURVEYING.—Pacing; ranging; preliminary location of mining claims and filing of notice of location; adjustment of Locke level; topographical survey of mining claim by pacing and hand level.

II. LAND SURVEYING.—Adjustment of compass; subdivision of land; farm survey; city survey; adjustment of solar attachments; official survey of mining claim.

III. TOPOGRAPHICAL SURVEYING.—Adjustment of transit; repetition traverse; azimuth traverse; adjustment of plane table instrument; topographical survey with plane table; topographical survey with transit and stadia; tying up of topographical survey to triangulation system.

IV. GOEDETIC SURVEYING.—Measurements of base line; triangulation, including computations and adjustment of quadrilateral; adjustment of engineers' level; determination of elevation of bench marks and triangulation points by levelling; observation on Polaris with transit for determination of true azimuth.

V. RAILROAD SURVEYING.—Reconnaissance with clinometer and pocket compass; preliminary survey with transit, chain and engineers' level, topography by pacing and hand level; permanent location with transit, steel tape, and engineers' level; computation of simple and compound curves; setting curve and line stakes with transit and steel tape; profile levelling; plotting on profile sheet and establishment of grade; cross-sectioning; computation of cuts and fills; computing and laying in turnouts, frogs, switches and Y junction curves.

Maps are required to be made of the mining claim pacing survey, the mining claim official survey, the azimuth and repetition traverses, the farm survey, the city survey, the stadia survey, and the railroad survey.

The class is divided into squads, each man being required to do every kind of work with every instrument used, make a full set of notes of the work done by his squad, and from those notes make the maps in the drawing room.

50 hours per week. Required of all students in the School of Mines.

23. ELEMENTS OF MASONRY AND CONCRETE CONSTRUCTION

Mr. LAMMIE

Fall Term, 5 credits.

This is an elementary course, designated to meet the needs of mining engineers. It comprises a brief outline of the theory, and a study of practical construction of: reinforced concrete beams and slabs, masonry and concrete foundations, retaining walls and arches. The laboratory exercises include the testing of cements, sand, gravel, mortar, and concrete specimens.

Three lectures, and six laboratory hours per week. Required in Group I.

Mechanical Engineering

4. PRIME MOVERS

Mr. Richardson.

Winter Term, 3 credits.

A brief study of the construction and operation of steam boilers, engines and turbines; and of gas engines and producers.

Two lectures and three laboratory hours per week. Junior year, Groups I, II and IV.

Pre-requisites: Mechanics 1; Physics 13.

Electrical Engineering

2. APPLIED ELECTRICITY

Assistant Professor HARRIS

Winter Term, 3 credits.

This is a short course designed to meet the requirements of those not specializing in Electrical Engineering.

Two lectures and recitations and three hours laboratory per week. Junior year, Groups I, II and IV.

Pre-requisite: Physics 13.

Economics

3 E. ECONOMICS

Assistant Professor Crafer.

Winter Term, 3 credits.

A brief resume of economic theory. Discussion of practical economic problems; wages, interest, rent, currency, banking, taxation, trusts, tariff, socialism.

Text-books and lectures.

10, 11. TRANSPORTATION

Mr. Flocken.

Fall and Winter Terms, 2 credits each term.

The origin and growth of the American railways. Their present ownership and control. The organization of the railway company, and how it does its work. Railway financiering. The freight, passenger, express and mail service. Railway abuses. Regulation by the states and by the Federal Government. The Interstate Commerce Commission. Government ownership in the light of foreign experience. Railway rates and fares. Electric railway transportation. Ocean transportation. Ocean highways and seaboard terminals. The organization of ocean freight, passenger, express and mail service. The merchant marine. The question of subsidies. The river, lake and canal systems of the United States. The increasing importance of the inland waterways question. Text-book, lectures and assigned readings. Text-book, Johnson's Elements of Transportation.

13. MODERN INDUSTRIES

Mr. Flocken.

Fall Term, 2 credits.

A study of the leading American industries, physiographic control, source and supply of raw material, agricultural resources. Factors affect-

ing the location of industry. Sources and application of power. Manufacturing methods, and factors affecting cost of production. Large scale versus small scale production. Internal commerce and foreign trade. Lectures, assigned readings and reports.

16. INDUSTRIAL MANAGEMENT

Mr. Flocken.

Winter Term, 2 credits.

Advantages of various methods of business organization and management. The internal management of the large business or plant and the differentiation of the duties of various departments. Profit-sharing schemes. Labor problems. Markets and methods of distribution. A study of actual industrial conditions by visits to the mills and shops of Pittsburgh, special attention being given to the handling of raw material, the arrangements of plant, and shipping facilities. Lectures, assigned readings, reports, field work.

21. CORPORATION FINANCE

Professor Holdsworth.

Fall Term, 2 credits.

Types of business corporations. The genesis of the trust. The financial organization and management of corporations. The promoter and the underwriting syndicate. The disposition of gross earnings and the provision of new capital. Charter, articles and by-laws. Stockholders' powers, rights and liabilities. Dissolution, receiverships and reorganizations. Lectures and text-book, assigned readings and reports. Text-books, Lough's Corporation Finance.

24. INVESTMENTS

Professor Holdsworth.

Winter Term, 2 credits.

The general characteristics and merits of government and municipal bonds, and of railway, industrial, public service corporation, power irrigation securities. The farm and city mortgage. How securities are purchased and marketed. The organization of the investment business. A study of fluctuations in bond and stock prices to determine the influence acting upon security values. Analysis of typical securities and railroad reports. Examination of savings banks and trust company holdings. Lectures, assigned readings and reports.

46. CONTRACTS AND SPECIFICATIONS

Assistant Professor Crafer.

Spring Term, 3 credits.

In this course are presented the essential elements of a contract, the law pertaining thereto and parties who may contract. The consideration, discharge and remedies for breach of contract. Forms of proposals, specifications and illustrative examples of complete contracts and specification for various engineering projects are given.

Sociology

1, 3. THEORY OF SOCIOLOGY

Assistant PROFESSOR CRAFER. . . . Fall and Spring Terms, 2 credits each.

This course will be arranged specially for the students in the Post-Senior year, and will include a study of the development of sociology, its importance and place in the social sciences, and of the underlying biological physical and psychical factors in sociology.

Psychology

20. PSYCHOLOGY FOR STUDENTS IN THE SCHOOL OF MINES

PROFESSOR WHITE Fall Term, 5 credits; Spring Term, 1 to 3 credits.

A course designated to give

(a) The general principles of psychology;

(b) A general survey of the whole field of psychology;

(c) Special applications to the problems of individual differences of character; race psychology; suggestion and choice, custom, conventionality, imitation, cooperation, competition; psychology of the gang, the crowd, the mob; psychology of responsibility; ownership, etc., etc.; psychology applied to everyday life.

This course is arranged for students taking the course in Management. Five lectures per week will be given in the fall term.

During the spring term the work will consist of conferences, at which will be discussed problems which have arisen during the field work of the winter term. This will be of very great value to all who expect to become executives.

Mineralogy and Petrography

Assistant Professor Leighton

1. GENERAL MINERALOGY. Fall Term, 2 credits.

Designed primarily for civil engineering students but open to anyone desiring a brief course in the subject. About 75 minerals and a few common rocks are studied.

- 2, 3, 4. GENERAL MINERALOGY.

Fall, Winter and Spring Terms, 3 credits each term.

Includes the subjects of crystallography, mineralogy and lithology. Required of all students in the School of Mines and open to any qualified student who desires a comprehensive knowledge of the subject. About 250 mineral species are studied and stress laid on the actual determination of unlabelled material.

5. MATHEMATICAL CRYSTALLOGY. Winter Term, 2 credits.

The calculation of axial ratios and other constants in crystals and the methods of projecting and drawing crystals.

Pre-requisites: Math. 4; Min. 2, 3, 4.

6. ADVANCED MINERALOGY.

Advanced or research work in crystallography, mineralogy or lithology. Primarily for graduate students, but open to all having sufficient training. Credits and courses to suit the needs of the student.

Pre-requisites: Chem. 3, 4, 8; Min. 2, 3, 4.

- 7, 8, 9. PETROGRAPHY.

Includes a study of optical crystallography, the optical determination of minerals, and the determination and classification of rocks by microscopic methods.

Pre-requisite: Min. 2, 3, 4.

10. ADVANCED PETROGRAPHY Credits vary.

Designed to meet the needs of individual students.

Geology

1. GENERAL GEOLOGY

Fall Term, 3 credits.

Instruction is given by means of text-book and lectures on the general principles of geological science, including the probable origin and structure of the earth; volcanic and earthquake action; the destructive and reconstructive action of air and water, both surface and subterranean; the important earth-building minerals and rocks, their alterations and accidents; geological topography, etc. Text-book, Scott's Introduction to Geology.

Required of all Sophomores.

2. STRATIGRAPHICAL GEOLOGY

Winter Term, 3 credits.

The object of this course is to familiarize the student with the ancient life-history of the earth, the lithological structure of the successive sedimentary formations, their characteristic fossils, origin, their order of superposition, their upheavals and accompanying eruptive phenomena, their distribution in time and space, and such other facts as the student of Stratigraphy needs to learn. The principles of correlation of contemporary (homotaxial) deposits by means of their faunal contents will also be elucidated.

Required of all Sophomores.

3. STRUCTURAL AND FIELD GEOLOGY

Spring Term, 5 credits.

This course is intended to cover the general principles of geology in their applications to engineering and field geology.

Required of all Sophomores.

4, 5, 6. INVERTEBRATE PALEONTOLOGY

Fall, Winter and Spring Terms, each 4 credits.

In this course it is intended to present a general survey of the field of invertebrate paleontology. The work will consist of one lecture, one recitation and six hours laboratory per week. Beginning with the Protozoa, each of the groups of invertebrates whose remains are preserved as fossils will be studied.

Required in Group III.

Economic Geology

Assistant Professor Leighton

1, 2, 3. ECONOMIC GEOLOGY.

Fall, Winter and Spring Terms, 3 credits each term.

The mode of occurrence, origin distribution and uses of the non-metallic and metallic mineral resources are discussed, special attention being given to the deposits of the United States.

Pre-requisites: Min. 2, 3, 4; Geol. 1, 2, 3.

Required in Groups I and III.

4, 5, 6. GEOLOGY OF THE IRON ORES.

Fall, Winter and Spring Terms, 2 credits each term.

Given in alternative years with Ec. Geol. 7, 8, 9. Not given in 1912-1913.

9. Not given in 1912-1913.

Taken with Ec. Geol. 1, 2, 3.

7, 8, 9. GEOLOGY OF COAL.

Fall, Winter and Spring Terms, 2 credits each term.

Given in alternate years with Ec. Geol. 4, 5, 6. Given in 1912-1913.

Must be preceded by or taken with Ec. Geol. 1, 2, 3.

10 11, 12. SEMINAR.

Fall, Winter and Spring Terms, 1 credit each term.

The current periodicals and new publications are reviewed.

Must be preceded by or taken with Ec. Geol. 1, 2, 3.

Required in Group III.

13. ADVANCED ECONOMIC GEOLOGY.

Credits vary.

This course is intended primarily for graduate students and can be planned to suit the individual.

Pre-requisite: Ec. Geol. 1, 2, 3.

Mining

Professor Meller, Assistant Professor Dr. Wallgren, Mr. Conrad.

The aim of the curriculum in Mining Engineering is to impart such knowledge as will enable the student to successfully carry through a mining enterprise. In order to intelligently conduct mining operations, he will be called upon as an engineer to employ the principles of mathematics, physics, and mechanics; the sciences of geology, mineralogy, chemistry and metallurgy; and the arts of civil, mechanical, and electrical engineering; he must also have capacity for organization and business management.

The principles, sciences, and arts mentioned are taught by specialists in the different departments, their particular application to Mining being specially emphasized.

Two lines of election are offered to the student:

The Mining of Coal.

The Mining of Metals and Stone.

Besides the courses under the heads mentioned, there are courses relating to business methods and the economics of mining, which deal with the problems confronting the mine manager, operator, and financial agent. A knowledge of these subjects has usually been gained by experience alone in the active mining-field; but a number of carefully selected courses of this character are included in the curriculum of the School.

In connection with the department is a laboratory, equipped with the most modern machinery used in underground work, steam, air, and electricity being directly available as power.

Class instruction is supplemented, where possible, by visits to mines in the vicinity; by reference to mine maps, models, drawings, and descriptions of plants, etc.

1, 2. PRINCIPLES OF MINING

Fall and Winter Terms, 3 credits each term.

This course is intended to give a resume of the principles of mining and is required of all students in the School. It is also to serve as a basis for subsequent study in the department. The course includes instruction in:

1. Modes of occurrence of minerals; as beds or seams, veins, and masses.
2. Prospecting; aids, methods, outfits, etc.
3. Boring; purposes and methods of.
4. Breaking ground; by hand tools, by machinery; blasting.
5. Support: rock pillars, timber, masonry, brickwork, metallic supports.
6. Exploitation: open, subaqueous, and underground workings, etc.
7. Haulage: methods not involving the use of rails; railways; aerial ropeways.
8. Hoisting: motors, drums, pulley frames; ropes and rope attachments; receptacles, as buckets, cages, skips, safety appliances etc.
9. Drainage: surface and mine.
10. Ventilation: pure air, constitution and requirements; mine air pollution; natural and artificial ventilation; testing mine air; accidents from mine gases, and their prevention; rescue and resuscitation; etc.
11. Lighting: candles, torches, lamps.

Visits of inspection are made to mines in the vicinity in order that the students may become familiar with the practical application of the principles discussed in the class-room.

3. ORE MINING METHODS

Spring Term, 4 credits.

Methods of support in extraction of ore; methods of stoping and mining in narrow and wide veins and bedded and massive deposits, including stull and square-set mining, filling and caving methods, and open-cut work. Required in Metal option, Group I.

4. COAL MINING METHODS

Spring Term, 3 credits.

A study of mining methods used in the various seams in the anthracite regions of Pennsylvania; the methods as found in the Pittsburgh, Connellsville, Fairmont, New River and other districts; also a study of the longwall system as found in Illinois.

Required in Coal option, Group I.

5. MINE-GASES AND EXPLOSIONS

Spring Term, 3 credits.

Treats of the composition and physical properties of gases commonly found in mines. Effect of dust and atmospheric conditions in explosions. Mine rescue work, underground hospitals, etc., etc. Concludes with a study of mine lamps and gas indicators.

Required in Coal option, Group I.

6. MINE-GAS ANALYSIS

Fall Term, 3 credits.

The analysis of mine air to determine percentage of CH_4 , CO_2 and CO in return air-current.

Required in Coal option, Group I.

7. VENTILATION

Winter Term, 4 credits.

A study of the laws governing the passage of air-currents in a mine, and involving the use of formulae with which a study of ventilation is so closely associated.

Required in Coal option, Group I.

8. COMPRESSED AIR IN MINING

Fall Term, 3 credits.

A study of air compression, expansion, flow of air through pipes, the various types of air compressors and of machines using compressed air as power.

Elective. Advised in Group I.

9. POWER TRANSMISSION IN MINES

Winter Term, 2 credits.

A lecture course bearing on the installation of boilers, engines, generators, air compressors, etc., at mines, and the transmission of power to all sections of the mine interior.

Required in Group I.

10. PLACER MINING

Fall Term, 2 credits.

Occurrence of auriferous gravel deposits, methods of prospecting, development and working. Ground sluicing, river mining, drift mining, hydraulicking and dredging.

Required in Group III. Advised in Metal option, Group I.

11. UNDERGROUND SURVEYING

Winter Term, 3 credits.

In this course are taught: The theory of underground practice in surveying; carrying the meridian underground by various methods, such as

2-wire, 3-wire, 4-wire, and with auxiliary telescope; survey of secondary openings, recording of survey, use of mine maps, etc. The three hours practical work per week are utilized by the student in acquiring familiarity with setting up under instead of over a point, and in sighting in the dark, use of the tape, plotting of notes, etc. Several days' underground surveying are included in the Field Trip (see page 46).

Required in Groups I and III.

12, 13. MINE PLANT DESIGN

Winter and Spring Terms, 3 credits each term.

Design of surface structures, such as head-frame, ore-bins, tipple, boiler house, etc.

Required in Group I.

14. PROJECTION OF MINE WORKINGS

Spring Term, 3 credits.

Under this heading the student is taught the projection of mine workings, the order in which rooms are to be worked and ribs to be drawn, and the writing of specifications governing methods of working, ventilation, etc.

Required in Coal option, Group I.

15. FIRST AID AND MINE RESCUE WORK

Spring Term, 2 credits.

This course includes instruction in the following subjects: Bruises, Sprains, Fractures; Shock, Burns and Gas Poisoning, etc.; Principles, Design and use of the Helmet and Mouth-Breathing Devices, Resuscitation Apparatus, and in the Methods of Mine Rescue Work.

Required in Group I. Advised in Group II.

16, 17. COKE MANUFACTURE

Winter and Spring Terms, 3 credits each term.

A study of the physical properties and methods of manufacture of coke. The various types of ovens in use in this country and abroad are studied. Special attention is given to by-product ovens.

Required in Coal option, Group I.

18, 19. MINE ECONOMICS

Fall and Winter Terms, 3 credits each term.

This course covers: Considerations which should precede the opening of mines, as topography, labor conditions, climate, transportation facilities, etc.; incorporation and capitalization; promotion of mining and exploration companies; investments in mines and mining stocks; reasons for failures in mining; mine administration; details of costs for operation, maintenance, depreciation and amortization; etc. Following this is a study of mining costs of representative companies in the various mining fields of the world.

Required in Group I.

20. MINE VALUATION

Spring Term, 2 credits.

A study of the factors which assist the engineer in determining the value of a producing mine or a prospect; conduct of the examination; report; etc.

Required in Groups I and III.

21, 22. MINING LAW

Winter and Spring Terms, 2 credits each term.

The principles of law and introduction to mining law; followed by general mining law.

Required in Groups I and III.

23, 24, 25. SEMINAR

Fall, Winter and Spring Terms, 1 credit each term.

This course is given to familiarize the student with current technical literature.

Required in Group I. At intervals the Seniors in all groups meet together for discussions.

26. INSPECTION TRIPS

Spring Term, 2 credits.

During the Spring term of the Junior year, Saturdays are set aside for visits of inspection to working coal mines in the vicinity; this supplements the work of the Field Trip, page 46. Before each visit the class is assembled and told what particular features to observe on that week's trip, and written reports are required in every case.

27, 28. MINING FOR PETROLEUM, NATURAL GAS, ASPHALTUM AND OTHER HYDROCARBONS

Elective. Will be given at any time a sufficient number apply.

Metallurgy

Professor Goodale, Assistant Professor Ray, Dr. Benner, Mr. Shuey.

Metallurgy is the art of extracting metals from their ores or other sources and preparing the metal for practical use. It is often considered to be a branch of applied chemistry; it is so, but draws as well upon the various divisions of physics. To take up the study of metallurgy, a student should, therefore, be well prepared in the sciences of chemistry and physics.

The subjects considered in metallurgy are of a practical kind, and the cost of operations must generally be kept in view in order to conduct them profitably. The general subject may be subdivided in a number of ways, as for instance: 1. Mechanical treatment of ores. 2. Chemical treatment. 3. Furnace operations. 4. The finished product.

Under this head of mechanical treatment comes the preparation of the raw product of the mines by mechanical processes only for more expensive treatment to follow. This includes ore-dressing and coal-washing, and takes up in detail the study of crushing ores, concentrating by jigs or tables depending on the difference in specific gravity between minerals, or by magnetic or static separators, or concentration by oil processes, etc.

The chemical processes include the study of cyanidation, by which most of the gold is recovered. There are also many other chemical processes, such as those for recovering copper from low grade ores, silver by hypsulphite leaching, etc. This may also be considered to include many of the extremely important electro-chemical methods such as the refining of copper, gold and silver, by which processes metals of the highest purity are obtained commercially.

The study of furnace operations, however, is still the great study of the metallurgist. These include such great furnaces as the iron blast furnace, the open hearth and Bessemer furnaces for refining iron and producing steel, and all the furnaces used in the iron and steel industry. In the metallurgy of each metal certain furnaces are used—in copper smelting, both blast and reverberatory furnaces, sometimes of very great size, in zinc smelting, retort furnaces, and so on. The roasting of ores to remove impurities is studied under this head.

The finished product. It is the business of the metallurgist to secure the metal from its ore, and to get the metal into a condition fit for commercial use. Therefore the study of the properties of metals and alloys is of utmost importance to the metallurgist. The usefulness of a metal commercially hinges often upon the presence or absence of other elements to the extent of one-fifth of one per cent. or less, as for instance phosphorus in rail-steel can not be allowed to exceed that limit because of brittleness if more is present, and numerous other similar instances could be cited.

Therefore the metallurgist studies the operations of the iron and steel industry, the copper smelter, the gold and silver mill, the ore-dressing plant, etc. It is seen to be a very broad field, and any one man can become an expert in only a small section of it, in addition to having a good general knowledge of the whole field.

It is the aim of the school training to teach the underlying principles mainly, and give the student a good general knowledge of the field of metallurgy, together with as much more extended study of one branch as the time allotted will permit. The courses in Metallurgy are designed to prepare the student for work in the iron and steel plants, copper and lead smelters, gold mills, etc., both in the technical and managerial departments.

1, 2, 3. GENERAL INTRODUCTORY COURSE

Fall, Winter and Spring Terms, 5 credits each term.

A general study of the manufacture and properties of the common metals. Three recitations or lectures and six hours laboratory work are required each week. Text-book for fall and winter, Austin's Metallurgy of the Common Metals; for spring, Stoughton's Metallurgy of Iron and Steel. Required of all students in the School of Mines.

4, 5, 6. ORE DRESSING AND STAMP MILLING

Fall, Winter and Spring Terms, 3 credits each term.

This course is designed to give the student the principles and practice of breaking and concentration of ores. Two terms are devoted to crushing, grinding, sizing, jigging and other methods of concentration, the machinery used being studied in detail; and the third term to stamp milling and amalgamation. Text-book, Richard's Ore Dressing. Two terms are required of all students in the School of Mines, three for general metallurgy option, Group II, and three for metal option, Group I.

7, 8, 9. GENERAL METALLURGICAL PRINCIPLES

Fall Term, one lecture, 6 hours laboratory work; winter and spring terms, 3 recitations. 3 credits each term.

This course comprises a study of metals, alloys, metallurgical materials and products, fuels, furnaces, measurements, etc. Text-book, Fulton's Principles of Metallurgy. Required in Group II.

10, 11, 12. METALLURGICAL CALCULATION

Fall, Winter and Spring Terms, 3 credits each term.

A study of the calculations relating to quantities of heat and material, and cost involved in furnace and other operations of metallurgy. Text book, Richard's Metallurgical Calculations. Elective, advised for all candidates for metallurgical degree. 10 is required for either 11 or 12, but 12 does not necessarily require 11.

13, 14, 15. IRON AND STEEL

Fall, Winter and Spring Terms, 6 credits one term, 4 credits two terms.

This course comprises a detail study of the blast furnaces, the open hearth and other steel furnaces, and the principles and practice of the manufacture of iron and steel. Text books, Forsythe's Metallurgy of Iron, Harbord and Hall Metallurgy of Steel. Required in iron option, Group II.

16, 17, 18. COPPER, LEAD, THE MINOR METALS

Fall, Winter and Spring Terms, 4 credits each term.

This course is intended to give a thorough knowledge of the metallurgy of copper, lead, and other common metals. Text books, Peter's Practice of Copper Smelting; Hofman's Metallurgy of Lead; Schnabel's Handbook of Metallurgy. Required in general metallurgy option, Group II.

19, 20, 21. ELECTRO-METALLURGY

Fall, Winter and Spring Terms, 5 credits each term.

A careful study of the electrothermic and electrolytic processes applied to the recovery and refining of metals. Text book, Thompson's Applied Electro-Chemistry. Three recitations and 6 hours laboratory work per week. Elective. The course is advanced work and requires a knowledge of chemistry, elementary electricity and metallurgy. This course takes up some of the most interesting and promising phases of metallurgy.

22. GOLD AND SILVER

1 term, 4 hours recitation per week, 4 credits.

This course covers the metallurgy of gold and silver with special reference to the hydro or leaching processes such as cyanidation, the most important, chlorination, etc. The cyanide process is treated in detail on account of its present and growing importance. The refining of bullion by different methods is also thoroughly gone into. Elective, advised for candidates for metallurgical degree, general metallurgy option.

23. COAL WASHING

1 Term, 3 credits

The study of the preparation of anthracite and bituminous coal for the market or for special use. It includes crushing, picking, screening, jigging and other methods of washing. Required in coal option, Group I.

Pre-requisite: knowledge of ore dressing.

24, 25. FIRE ASSAYING

Fall Term, 3 credits; Winter Term, 2 credits.

This course is designed to give the student a thorough theoretical and practical knowledge of the assaying of ores of gold, silver, and platinum by fire methods. Commercial laboratory methods giving speed of manipulation are taught, as well as more refined methods for special accuracy. Elective. Required in general metallurgy option, Group II. One term required in Group I, and in iron option, Group II.

26. MANGANESE, NICKEL, COBALT, VANADIUM, CHROMIUM, TUNGSTEN, ETC.

Any Term, 3 credits.

A study of the manufacture, properties and uses of those metals that are of special interest in alloy steels. Elective.

Pre-requisite: general knowledge of metallurgy.

27, 28, 29. METALLURGICAL DESIGN

Fall, Winter and Spring Terms, 2 to 4 credits each term.

Draughting room work in preparing plans for metallurgical machinery, plants, processes, etc. Elective.

Pre-requisite: detailed study of the courses given referring to the problem undertaken.

30. INSPECTION TRIPS

Any Term, 1 credit.

Visits to metallurgical plants, equivalent of one afternoon a week for 10 weeks with reports and reading on each trip required. Elective, open to all students of the University.

31, 32, 33. GENERAL LABORATORY WORK, ADVANCED

Any Term, 2 to 18 credits.

Opportunity is given to the student to take up some problem of interest for detailed study and laboratory experimentation. Elective, open to advanced students.

34, 35, 36. REFERENCE WORK IN CURRENT LITERATURE

Fall, Winter and Spring Terms, 1 credit each term.

This course is to give the student familiarity with the technical press, and is required in Group II. Seniors in all groups meet together at intervals for discussions.

37, 38, 39. SPECIAL WORK

Any Term, 2 to 18 credits.

It is desired to give students an opportunity to specialize, as far as the facilities of the School permit, along any line in metallurgy. The work is carried along in each case as the occasion seems to require, in order to give each student the greatest advantage from his work. Elective.

Ceramics

Assistant Professor Leighton

The instruction in ceramics is planned so as to give each student a broad engineering training and to furnish him with the fundamental ideas regarding the properties of clays and their methods of manufacture. The course is arranged in such a way that by the proper use of the electives a man may undertake work along various lines, such as pottery and porcelain manufacture, the manufacture of refractories, brick manufacture, etc., although the main object in view will be to turn out men who will be fitted to enter any line of clay mining, clay manufacture, clay investigation or ceramic teaching and prove competent.

1, 2, 3. EXAMINATION AND TESTING OF CLAYS.

Fall, Winter and Spring Terms, 3 credits each term.

Includes a study of the origin and properties of clay and a study of the various physical and chemical tests generally applied in investigations.

Pre-requisites: Chem. 3, 5, 8; Physics 11, 12, 13.

4, 5, 6. TECHNOLOGY OF CLAYS.

Fall, Winter and Spring Terms, 2 credits each term.

The manufacture of clay products.

7, 8, 9. INSPECTION TRIPS.

Fall, Winter and Spring Terms, 1 credit each term.

Trips are made to nearby manufacturing plants.

Taken with Cer. 4, 5, 6.

10, 11, 12. POTTERY AND PORCELAIN.

Fall, Winter and Spring Terms, 2 credits each term.

A study of ceramic calculations, glazes, pottery bodies, etc.

Pre-requisite: Chem. 12, 13, 14.

13, 14, 15. CERAMIC LABORATORY.

Fall, Winter and Spring Terms, 5 credits each term.

Special work on the formation, burning and testing of clays and clay products.

Pre-requisite: Cer. 1, 2, 3.

16. ADVANCED CERAMICS.

Credits vary.

Work in this course can be arranged to meet the desires or need of the student. Primarily for graduate students.

17, 18, 19. SEMINAR.

Fall, Winter and Spring Terms, 1 credit each term.

By review of current literature and a study of the important papers previously issued, the student is made familiar with ceramic writings and the progress of the sciences.

Pre-requisite: 1, 2, 3.

20, 21. PLANT DESIGN.

Fall and Winter Terms, 3 credits each term.

Field Trip

6 credits.

The work of the Junior year is so arranged that the winter term ends one week earlier than in the other Schools of the University, and the spring term begins one week later. This leaves three weeks intervening for a field trip, which will be required of all students in the School, except those who, in the opinion of the Faculty, shall have had a sufficient amount and variety of practical experience to warrant their being excused. No fee is charged for this course. The necessary expenses for each student for the three weeks are estimated at \$75.00.

Three separate trips have been arranged, to alternate.

- (1) Eastern Pennsylvania and New York.
- (2) Michigan iron and copper country.
- (3) Southern coal, iron and copper fields.

The localities visited afford opportunity for advanced work in mining, metallurgy and geology. Special work is assigned to each student, and he is required to keep a careful record of his observations and investigations. At the end of the trip, a complete report, with sketches, is required. All work is done under the supervision of instructors from the School.

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BULLETIN

ANNOUNCEMENT OF THE

SCHOOL OF MINES

FOR

1913 - 1914



ENTERED JUNE 4, 1910, AT THE POSTOFFICE AT PITTSBURGH, PA., AS SECOND
CLASS MATTER, UNDER ACT OF CONGRESS OF JULY 16, 1894

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SCHOOL OF MINES

CALENDAR

1913

September 22-27	Monday to Saturday Registration.
September 26	Friday, 10:30 A. M. Opening Exercises, Fall Term, Memorial Hall.
September 29	Monday, Recitations begin.
November 27-29	Thanksgiving recess, Thursday to Saturday.
December 20	Saturday—Fall Term ends. Term Vacation from Monday, December 22 to Monday, January 5.

1914

January 5	Monday—Winter Term begins.
February 28	Saturday—Charter Day, a holiday.
March 28	Saturday—Winter Term ends.
March 23	Monday—Spring Vacation of one week begins.
March 30	Monday—Spring Term begins.
April 10	Good Friday, holiday.
June 14	Sunday—Baccalaureate Sermon.
June 17	Wednesday—Commencement.
June 22	Monday—Summer Term begins.
August 29	Saturday—Summer Term ends.

OFFICES AND OFFICE HOURS

Office, State Hall, Grant Boulevard—Consultation Hours: 8:30 A. M. to 5:30 P. M.

General Office, State Hall; Telephone Schenley 2500.

For catalogues and other information, address the Secretary of the University, Grant Boulevard.

FACULTY

SAMUEL BLACK McCORMICK, D.D., LL.D., CHANCELLOR.

MARSHMAN EDWARD WADSWORTH, A.M., PH.D., EMERITUS Professor of Mining Geology; Curator of Geological and Mineralogical Collections.

SAMUEL ALFRED TAYLOR, C.E., Dean.

STEPHEN LINCOLN GOODALE, A.M., E.M., Professor of Metallurgy.

HARRY BERTINE MELLER, E.M., Professor of Mining.

HORATIO CADWALLADER RAY, B.S., Assistant Professor of Metallurgy.

HENRY LEIGHTON, A.B., Assistant Professor of Economic Geology.

ROBERT MOFFAT BLACK, A.B., B.S., E.M., Assistant Professor of Mining.

ROSWELL HILL JOHNSON, M.S., Assistant Professor of Geology, and of Oil and Gas Mining.

ALEXANDER SILVERMAN, Ph.B., A.B., M.S., Professor of Analytical Chemistry; Lecturer upon Glass Manufacture. In charge of Glass Research.

ANDREW BENNETT WALLGREN, M.D., Lecturer upon First Aid to the Injured.

JAMES ZACHARIAH ZIMMERMAN, B.S., Instructor in Mining.

SAMUEL BLACK LINHART, D.D., Secretary of the University.

INSTRUCTORS IN OTHER DEPARTMENTS GIVING INSTRUCTION IN SCHOOL OF MINES

FRANCIS CLIFFORD PHILLIPS, A.M., Ph.D., Professor of Chemistry.
 ALBERT ELLIS FROST, A.M., Sc.D., Registrar. Professor of Mathematics.
 REID THOMAS STEWART, Ph.M., C.E., Professor of Mechanical Engineering.
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 HENRY ADOLPH KOHMAN, Ph.D., Professor of Organic Chemistry.
 IDEN FOSTER RICHARDSON, B.S., in M.E., Assistant Professor of Mechanical Engineering.
 LESLIE HUNTINGTON HARRIS, B.S. in E.E., Assistant Professor of Electrical Engineering.
 PHILIP WARNER HARRY, Ph.D., Assistant Professor of Romance Languages.
 CALVIN NAFTZINGER WENRICH, A.M., Ph.D., Assistant Professor of Physics.
 THOMAS W. B. CRAFER, Ph.D., Assistant Professor of Sociology.
 IRA GRAESSLE FLOCKEN, A.M., Assistant Professor of Industry and Accounting.
 LESTER A. PRATT, M.S.
 HARRY P. CORLISS, B.S.
 ROBERT REX SHIVELY, B.S.,
 HOWARD DIMOCK CLAYTON, A.B.,
 SAMUEL RAY SCHOLES, Ph.D.,
 CLINTON WILLARD CLARK, A.M.,
 ROY HUTCHISON BROWNLEE, Ph.D.,
 } Assistant Professors of Chemistry.
 ELLIS EDWIN BANKSON, B.S. in C.E., Instructor in Civil Engineering.
 JOSEPH SIOUSSA LAMBIE, C.E., Instructor in Graphics.
 AVVEMILIO PIERUCCI, LL.D., Instructor in Italian.
 JOHN WEBER, M.E., Instructor in Practical Mechanics.
 ORRIN WILSON ALBERT, A.M., Instructor in Mathematics.
 LAWRENCE WYLIE BURDICK, A.M., Ph.D., Instructor in German.
 EDWARD HOWARD DYCHE, M.E., Instructor in Mathematics.
 LOUIS JAY HEATH, A.M., Instructor in English.
 LOUIS FRANKLIN SNOW, Ph.D., Instructor in English.
 ISAAC BOYCE, D.D., Instructor in Spanish.
 FRANK D. SHUMAKER,
 HUGH CLARK, A.M.,
 WILBER ABRAM HOBBS, A.B.,
 } Instructors in Chemistry.
 ROY H. UHLINGER, A.M., Instructor in Gas Analysis.
 GEORGE SWERGER, Assistant in Practical Mechanics.
 DAYTON ULREY, A.M., Instructor in Physics.
 CHARLES SHIVELY MILLER, Physical Director and Director of Athletics.

LOCATION

STATE HALL, the SCHOOL OF MINES BUILDING, is located at the corner of Grant Boulevard, Bayard Street and Parkman Avenue, opposite the Soldiers' Memorial, and near the Carnegie Institute, including Museum and Library. It is readily accessible from all parts of the city.

SPECIAL ADVANTAGES

The location of Pittsburgh, in the very heart of the bituminous coal fields of the Appalachian system, and in the most richly productive oil fields of Western Pennsylvania, with the great concentration here of mining, metallurgical and ceramic interests, makes this undoubtedly one of the most advantageous points in the United States in which to study mining, metallurgy and ceramics.

It is also conveniently located with reference to the bituminous coal fields of Ohio and West Virginia, the anthracite fields of Eastern Pennsylvania, and the Lake Superior iron and copper region.

EQUIPMENT

The buildings of the University are new and embody the latest ideas of design in class-rooms, drafting-rooms, laboratories, etc.

1. THE SMITH CABINET. This collection was formed by the two sisters whose name it bears, and is rich in mineralogical and zoological specimens. Especially is it noteworthy for the size and beauty of the objects from the mineral kingdom.

2. THE MINERALOGICAL LABORATORY is equipped with thousands of specimens and the latest improved apparatus for lecture purposes and the students' laboratory work in crystallography, mineralogy and petrography.

3. THE GEOLOGICAL COLLECTION. A collection showing the ores, coals, clays, and building stones as they occur in North America is being acquired, and will be a valuable aid in the study of economic geology.

Besides the special geological collections arranged in the laboratories and lecture-rooms of the School of Mines, the arrangements made through the courtesy of the Director and Trustees of the Carnegie Museum, with part of the staff, afford abundant opportunity for paleontological study.

4. THE FIELD-INSTRUMENT EQUIPMENT includes a large assortment of the various types and makes of instruments used in land surveying, railroad surveying, construction work, leveling, geodetic surveying and mine surveying. The instruction of the student in the care, adjustment and use of the various types of instruments has been kept clearly in mind and well provided for in the selection of equipment.

5. THE MINING LABORATORY is equipped with mine models, miners' picks, shovels; hand drills; breast drills; rock-drills; coal-mining machines; open and safety lamps; instruments for measuring the velocity of air currents; etc.; and it is planned to reopen and completely equip during the coming year, a mine located on the University Campus, near the School of Mines Building.

6. THE OIL AND GAS LABORATORY is equipped with apparatus for experimental work in connection with the course in Petroleum Engineering, as well as for original research.

7. THE ASSAYING AND METALLURGICAL LABORATORIES are equipped with laboratory rock crushers, sieves, assay-balances, etc., gas and coal-fired muffle furnaces, and a gas-fired pot furnace. A regenerative crucible furnace for steel melting experiments is being planned for. A small cyanide

plant has just been installed, capable of treating lots of two hundred pounds of ore by either percolation or agitation methods. The electro-metallurgical equipment has been extended so as to provide opportunity for small scale electrolytic and electric furnace experiments. A chemical laboratory is equipped with all apparatus for the necessary analytical work. Measuring instruments, such as pyrometers, calorimeters, etc. are supplied.

8. THE CERAMIC LABORATORY is equipped with a large jaw crusher, briquette machine for tensile strength tests, vicat needles, a large gas-fired laboratory kiln, a small electric muffle furnace, polarizing microscope, sieves, molds, etc. With some additional equipment soon to be obtained, the laboratory will be prepared to make all necessary physical and chemical tests on clays and to carry on special research work on fire clays, pottery materials, etc.

9. THE CHEMICAL LABORATORIES. These, with the lecture-room, occupy the entire third floor of the Engineering Building. Both lecture-room and laboratories are equipped throughout in the most modern manner. Separate laboratories have been installed in the following branches: Introductory Chemistry and Qualitative Analysis; Quantitative Analysis, with Balance Room in connection; Gas and Fuel Analysis; Water Analysis; Physical and Electro-Chemistry; Spectroscopy; Photography and Research. On the fourth floor there is a special room for preparation and storage of distilled water, which is delivered by gravity to the various laboratories where it is on tap. A spacious store-room permits the distribution of supplies in such a manner that the requirements of the students are promptly met. Machinery for suction and air pressure has been installed and a first-class ventilating system provided so that the air in the laboratories may be pure at all times. The department library is well supplied with works of reference on chemistry for students' use.

10. THE PHYSICAL LABORATORIES. The lecture-room is provided with all the appliances to facilitate a complete course of experimental lectures.

The general physical laboratory is very fully equipped with new apparatus, and is complete in its appointments in every respect. Smaller laboratories are provided for photometry, advanced laboratory practice and research.

A well-equipped shop and mechanic provide excellent facilities for making and repairing apparatus.

The equipment of the department is new and includes an excellent collection of instruments for accurate measurement and investigation.

11. THE MATERIALS TESTING LABORATORY is equipped with machines and instruments for the measurement of the physical properties of the materials of construction, and for tests on manufactured specimens.

There are universal testing machines, ranging from 50,000 lbs. to 200,000 lbs. capacity, for tension, compression, and flexure tests. The 200,000 lbs. capacity machine is capable of taking 15 foot columns, tension specimens accordingly, and flexure specimens up to 20 ft. lengths.

The laboratory also contains a 230,000 inch-pound torsion machine, with a three-inch chucking capacity, and for lengths up to 16 feet; a hand-power flexure machine of 5,000 lbs. capacity; two automatic briquette testing machines, standard molds, scales, sieves, moist closet and other similar apparatus necessary for the examination of cements, cement mortars, and concrete.

12. THE STEAM AND POWER LABORATORY. There is provided the usual equipment for measuring the pressure, temperature, and flow of steam, such as gauges, thermometers, calorimeters, condensers, and indicators, together with suitable apparatus for standardizing and calibrating these.

A Babcock & Wilcox 100 H. P., 200 lb.-pressure boiler, with a super-heating chamber, is used in experimental and power-plant work.

The equipment includes a composite cross-compound steam engine, $7\frac{1}{2}$ and 18 by 14 inches, arranged to run condensing or non-condensing; high-pressure cylinder controlled by single valve; low-pressure cylinder controlled by four Corliss-type valves. The engine is provided with friction brake, which serves for applying loads and for measuring the power delivered at the wheel; and is arranged so that either side may be operated as a simple engine, condensing or non-condensing.

A two-cylinder Westinghouse gas engine, provided with all necessary apparatus for making gas-engine tests is used for experimental purposes. In addition to this, there are located in the laboratory two three-cylinder Westinghouse engines for power purposes.

A motor-driven air-compressor furnishes air for laboratory purposes. and is arranged for use in experimental work.

13. THE DYNAMO LABORATORY. The dynamo-room of the electrical laboratory contains the usual equipment of direct-current and alternating-current motors and generators, and transformers, of different makes and capacities. This includes direct-current generators, constant and variable-speed direct-current motors, single-phase and polyphase induction motors, single-phase series motors, two-phase and three-phase synchronous converters, a. c.-d. c. motor-generator set, and a General Electric mercury-arc rectifier. The laboratory is well equipped with accessory apparatus, such as measuring instruments, brakes, load and starting rheostats, dynamometers, induction regulators, etc. A large floor-crane facilitates the rapid and convenient arrangement of apparatus for the different tests, while a well appointed three-panel switchboard distributes power of the desired kind and voltage to any part of the laboratory.

14. THE HYDRAULIC LABORATORY. For hydraulic experiments there are a Worthington two-stage turbine pump driven by variable-speed motor, a Pelton wheel, and receiving and measuring tanks with weir discharge. There are also water-meters, orifices, nozzles, and a Venturi meter for determining the flow of liquids.

15. PRACTICAL MECHANICS EQUIPMENT. For Pattern-work the equipment consists of wood-working machinery, modern work-benches and tools necessary for pattern-work.

For Foundry-work the equipment consists of the best modern types of melting-furnaces with necessary apparatus for instruction in the principles of molding, core-making, etc.

For Forge-work there are special forges and furnaces, of gas and coal-fired types, including annealing, hardening, and tempering furnaces, a special barium chloride furnace for the treatment of high-speed steels and a 100 pound air hammer.

For Machine-work there are modern belt and motor-driven machines, including screw-cutting lathes, speed lathes, milling machines, planer, shaper, drill-presses, grinding machines, power hacksaw, necessary accessory tools, etc.

16. THE UNITED STATES' EXPERIMENTAL TESTING STATION AND BUREAU OF MINES, for the investigation of mine explosions and other factors relating to mining. Its work is available for the students, who are taught there: First Aid to the Injured, and Mine Rescue Work, receiving certificates therefor from the United States Government, and the United States Red Cross Association.

17. THE LIBRARY. The total number of volumes in the UNIVERSITY LIBRARY is about 7,500. The Reading Room is at present maintained in connection with the Library and is well supplied with the leading scientific periodicals.

THE CARNEGIE LIBRARY, with its immense collection of scientific books and periodicals, is near the School of Mines Building, and all of the files and collections are available for the use of students.

REQUIREMENTS FOR ADMISSION

All candidates for admission to the School of Mines must be at least seventeen years of age and furnish testimonials of good moral character. Those who come from other institutions must present certificates of honorable dismissal.

METHODS OF ADMISSION

I. CERTIFICATES of the College Entrance Examination Board and of the New York Regents are accepted in lieu of entrance examinations at the University.

For information concerning the dates upon which the examinations of the College Entrance Examination Board are to be held, address The Registrar of the University of Pittsburgh.

II. CERTIFICATES FROM ACCREDITED SCHOOLS Instead of examination, certificates from high schools and academies whose work has been approved by the University as being equivalent to that required for admission to the Freshman class, will be accepted. The official blank provided by the University should be used. It may be obtained upon application to the Registrar or Dean.

III. FROM OTHER COLLEGES. Students from other institutions whose entrance requirements are equivalent to those of the University of Pittsburgh and which offer equivalent courses of study, will be given provisional credit for the work done and admitted to advanced standing without examination. If their work proves satisfactory, the provisional credits will be made permanent.

IV. SPECIAL STUDENTS. Students showing satisfactory evidence of ability, but who are not candidates for a degree, may be admitted without examination to take such work as they are prepared for. This includes students taking irregular or partial courses owing to lack of time to follow the regular course as well as persons of age and experience in practical work who wish to take special courses.

SUBJECTS OF EXAMINATION

For admission to the School of Mines the student who is a candidate for a degree must offer fifteen units, a unit being the equivalent of four recitations per week of one hour each for one year, or five recitations of three-quarters of an hour each.

The units are as follows for 1913:

English, a, 3 units.

Mathematics, a, c, Algebra, $1\frac{1}{2}$ units.

Mathematics, b, d, Plane and Solid Geometry, $1\frac{1}{2}$ units.

History, a, b, c, or d, 1 unit.

German or French, a, b, 2 units. (Spanish may be substituted).

Physics, 1 unit.

Five additional units must be offered from the following subjects:

Chemistry, 1 unit.
Biology, 1 unit.
Drawing, 1 unit.
Physiography, $\frac{1}{2}$ unit.
Shop Work, 1 unit.
Advanced History, 1 unit.
Advanced English, 1 unit.
Latin, a, b, 1 to 2 units.
German, 2 units.
French, 2 units.
Spanish, 2 units.

EXPLANATION OF REQUIREMENTS FOR ADMISSION

English Composition and Literature

a. Three units. The preparation should include the following subjects:

(1) GRAMMAR—It is expected that the applicant will be familiar with the essentials of English grammar, and will be able to explain the construction of sentences that occur in the literature he has read.

(2) COMPOSITION AND RHETORIC—The student should know the elementary principles of rhetoric, and should be able to apply them in the construction of sentences and paragraphs, and in the planning of essays. The examination is chiefly practical, and involves the ability to write good English.

No student will be accepted whose paper is notably deficient in logical development of the subject, or in such details of form as spelling, punctuation, grammar, and division into paragraphs.

(3) LITERATURE—The books recommended are the Uniform College Entrance requirements in English. Other similar works will be accepted as equivalents.

The candidate is required to write one or more paragraphs on each of several subjects chosen from a considerably larger number given in the examination paper. The questions on all of the books assume a knowledge of subject-matter and structure, but those on the books prescribed for study and practice call for more detailed treatment than those on books prescribed for reading.

A—The books prescribed for reading and practice are indicated in the following groups:

Select two sub-divisions from each of the following groups, except when substitution is made from group 2-5, as provided below. Each sub-division is set off by semicolons.

Group 1. The Old Testament, including the most important narrative parts of Genesis, Exodus, Joshua, Judges, Samuel, Kings and Daniel, together with the books of Ruth and Esther; the Odyssey, with the omission of Books I-V, XV-XVII; the Iliad with the omission of Books XI, XIII-XV, XXI; Virgil's Æneid. English translations of the Odyssey, the Iliad, and the Æneid, of acknowledged literary merit, must be used.

An equivalent amount from Groups 2-5 may be substituted for the two sub-divisions of this group.

Group 2. Shakespeare's *Julius Cæsar*; *The Merchant of Venice*; *As You Like It*; *A Midsummer-Night's Dream*; *Twelfth Night*; *Henry V*.

Group 3. Goldsmith's *The Vicar of Wakefield*; either Scott's *Ivanhoe* or Scott's *Quentin Durward*; Hawthorne's *The House of the Seven Gables*; Thackeray's *Henry Esmond*; either Dicken's *David Copperfield*, or Dicken's *A Tale of Two Cities*; Mrs. Gaskell's *Cranford*; George Eliot's *Silas Marner*; Stevenson's *Treasurer Island*; Defoe's *Robinson Crusoe*, Part I.,

Group 4. The de Coverley Papers in *The Spectator*; Franklin's *Autobiography*; Bunyan's *Pilgrim's Progress*, Part I; Irving's *Sketch-Book*; Macaulay's Essays on Clive and Hastings; Thackeray's *English Humourists*; selections from Lincoln, including at least the two Inaugurals, the speeches in Independence Hall and at Gettysburg, the *Last Public Address*, and the *Letter to Horace Greely* together with a short memoir or estimate; Parkman's *Oregon Trail*; Thoreau's *Walden*; Huxley's *Autobiography* and selections from *Lay Sermons*, including addresses on *Improving Natural Knowledge*, *A Liberal Education*, and *A Piece of Chalk*; Stevenson's *Inland Voyage* and *Travels With a Donkey*.

Group 5. Palgrave's *Golden Treasury* (First Series), Books II and III, with special attention to Dryden, Collins, Gray, Cowper, and Burns; Gray's *Elegy in a Country Churchyard* and Goldsmith's *The Deserted Village*; Coleridge's *The Ancient Mariner* and Lowell's *The Vision of Sir Launfal*; Scott's *The Lady of the Lake*; Byron's *Childe Harold*, Canto IV, and *The Prisoner of Chillon*; Palgrave's *Golden Treasury*, (First Series), Book IV, with special reference to Wordsworth, Keats, and Shelley; Poe's *The Raven*, Longfellow's *The Courtship of Miles Standish*, and Whittier's *Snow-Bound*; Macaulay's *Lays of Ancient Rome*, and Arnold's *Sohrab and Rustum*; Tennyson's *Gareth and Lynette*, *Lancelot and Elaine*, and *The Passing of Arthur*; Browning's *Cavalier Tunes*, *The Lost Leader*, *How They Brought the Good News from Ghent to Aix*, *Home Thoughts from Abroad*, *Home Thoughts from the Sea*, *Incident of the French Camp*, *Herve Riel*, *Pheidippides*, *My Last Duchess*, *Up at a Villa—Down in the City*.

B—The books prescribed for study and practice are:

Shakespeare's *Macbeth*; Milton's *Lycidas*, *Comus*, *L'Allegro*, and *Il Penseroso*; Burke's *Speech on Conciliation with America*, or Washington's *Farewell Address and Webster's First Bunker Hill Oration*; Macaulay's *Life of Johnson* or Carlyle's *Essay on Burns*.

Applicants who are not graduates of accredited high schools must pass the uniform entrance examinations held by the College Entrance Examination Board or those held by the New York Regents.

b. One unit.

Advanced standing in English may be given to the graduates of high schools that have exceptionally strong and thorough courses in English throughout the entire four years. This requires additional work in literature and, especially, a thorough knowledge of the elementary principles of rhetoric, and the ability to write good English.

Mathematics

a. ALGEBRA THRU QUADRATICS.

One unit. The four fundamental operations for rational algebraic expressions. Factoring, determination of highest common factor and lowest common multiple by factoring. Fractions, including complex fractions, ratio, and proportion. Linear equations, both numerical and literal, containing one or more unknown quantities. Problems depending on linear equations. Radicals, including the extraction of the square root

of polynomials and of numbers. Exponents, including the fractional negative.

Quadratic equations, both numeral and literal. Simple cases of equations with one or more unknown quantities, that can be solved by the methods of linear or quadratic equations. Problems depending on quadratic equations. The binomial theorem for positive integral exponents.

b. PLANE GEOMETRY

One unit. The usual theorems and constructions of the textbooks, including the general properties of plane rectilinear figures; the circle and the measurement of angles; similar polygons; areas, regular polygons and the measurement of the circle. The solution of numerous original exercises. Applications to mensuration.

c. ADVANCED ALGEBRA

One-half unit. Ratio, proportion and variation, variables and limits, properties of series, including the binomial theorem for exponents of all kinds; the progressions; use of undetermined coefficients; permutations and combinations; logarithms, computation and use; summation of recurring series; method of differences; interpolation.

d. SOLID GEOMETRY

One-half unit. The usual theorems and constructions of good textbooks, including the relations of planes and lines in space; the properties and measurements of prisms, pyramids, cylinders, and cones; the sphere and the spherical triangle. The solution of numerous original exercises, including loci problems. Applications to the mensuration of surfaces and solids.

History

One unit each.

a. Ancient history, with special reference to Greek and Roman history, and including also a short introductory study of the more ancient nations and the chief events of the early Middle Ages, down to the death of Charlemagne (814).

b. Mediæval and modern European history, from the death of Charlemagne to the present time.

c. English history.

d. American history and civil government.

Each of the above topics is intended to represent one year of historical work, wherein the study is given five times a week, or two years of historical work, wherein the study is given three times a week.

Latin

One unit each.

a. Grammar and elementary prose composition. A thoro knowledge of all regular inflections, all common irregular forms, the fundamentals of syntax, and a select vocabulary.

b. *Cæsar*, Gallic War, books I-IV, or the equivalent from other books of the Gallic War or the Civil War, or *Nepos' Lives*. The examination consists of translation at sight of narrative prose similar to the above.

c. *Cicero*, the four orations against *Catiline* and the orations for *Archias* and for the *Manilian Law*, or the equivalent from other orations of *Cicero* or from his letters, or from *Sallust's Catiline* and *Jugurtha*, except that the orations for the *Manilian Law* and for *Archias* are required. Advanced prose composition. The examination consists of trans-

lation (together with historical, literary, and grammatical questions) partly of passages taken from the two required orations, and partly at sight of passages similar to the above in vocabulary, syntax, and range of ideas. In addition, there is an examination in prose composition.

d. Virgil, *Æneid*, books I-VI, or the equivalent from other books of the *Æneid*, or from the *Bucolics* or *Georgics*, or from Ovid *Metamorphoses*, *Fasti*, or *Tristia*, except that *Æneid* I, II and either IV or VI are required. The examination consists of translation (together with questions on grammar, prosody, literary and historical allusions, and subject-matter) partly of passages taken from the required books, and partly at sight of passages similar to the above in vocabulary, syntax, and range of ideas.

Greek

One or two units.

a. Greek Grammar and the elements, forms, constructions, conditional sentences and indirect discourse, etc. Composition. Translation into Greek of easy Attic prose based on the *Anabasis*.

b. Xenophon's *Anabasis*. Four books, Homer: Books I and II of the *Iliad*.

German

One unit each.

a. ELEMENTARY GERMAN. During the first year the work should comprise (1) careful drill upon pronunciation; (2) the memorizing and frequent repetition of easy colloquial sentences; (3) drill upon the rudiments of grammar; (4) abundant easy exercises designed, not only to fix in mind the forms and principles of grammar, but also to cultivate readiness in the reproduction of natural forms of expression; (5) the reading from 75 to 100 pages of graduated texts from a reader, with constant practice in translating into German easy variations upon sentences selected from the reading lessons.

b. SECOND YEAR GERMAN. During the second year the work should comprise (1) the reading of from 150 to 200 pages of literature in the form of easy stories and plays; (2) practice as before, in the translation into German of easy variation upon the matter read, and also in the reproduction, orally and in writing, of the substance of short and easy selected passages; (3) continued drill upon the rudiments of grammar.

Stories suitable for the elementary course can be selected from the following list: Grimms' *Maerchen*, Gerstaecker's *Germelshausen*, Heyse's *L'Arrabbiata*, Storm's *Immense*, Baumbach's *Der Schwierigersohn*, Schokke's *Der Zerbrochene Krug*, Hillern's *Hoher als Die Kirche*.

Among shorter plays the best available are perhaps: Benedix's *Der Prozess*, *Der Weiberfreund*; Elz's *Er ist nich eifersuechtig*; Wichert's *An der Majorsecke*; Wilhelm's *Einer mus sheiraten*.

c. THIRD YEAR GERMAN. The work should comprise the reading of about 400 pages of moderately difficult prose and poetry, with constant practice in giving, sometimes orally and sometimes in writing, paraphrases, abstracts, or reproductions from memory of selected portions of the matter read; also grammatical drill upon the less usual strong verbs, the use of articles, cases, auxiliaries of all kinds, tense and modes, and likewise upon word-order and word-formation.

Suitable reading matter for the third year can be selected from such works as the following: Freytag's *Die Journalisten* and *Bilder aus der Deutschen Vergangenheit*—for example, *Karl der Grosse*, *Aus dem Kzeuz-*

zuegen, Doktor Luther, Aus dem Staat Friedrichs des Grossen, Gerstaecker's Irrfahrten, Hoffman's Historische. Erzaehlungen, Riehl's der-Fluch der Schoenheit, Schiller's Wilhelm Tell, Der Neffe als Onkel, Das Lied von der Glocke, Wilderbruch's Das edle Blut.

French

One unit each.

a. ELEMENTARY FRENCH. In the first year the work should comprise (1) careful drill in pronunciation; (2) the rudiments of grammar; (3) easy composition; (4) the reading of from 150 to 200 duodecimo pages of easy French prose; (5) the writing of French from dictation.

b. SECOND YEAR FRENCH. During the second year the student should read from 300 to 400 pages of easy modern prose. Suitable texts are: Halévy's *L' Abbé Constantin*; Bruno's *Le tour de la France*; Malot's *Sans famille*; Labiche and Martin's *La poudre aux yeux* and *Le voyage de M. Perrichon*; Dumas' *L' Evasion du Duc de Beaufort*. Continued drill upon the rudiments of grammar, the mastery of the chief irregular verbs, dictation, practice in French conversation.

c. THIRD YEAR FRENCH. In the third year from 500 to 600 pages of French of ordinary difficulty should be read. The essentials of French syntax are required, with constant practice in the use of spoken French. Suitable texts are: Daudet's *Contes*; About's *Le Roi des Montagnes*; Merimée's *Colomba*; Augier's *Le Gendre de M. Poirer*; Mollière's *Le Bourgeois Gentilhomme*; Maupassant's *Contes*; George Sand's *La Mare au Diable*; Scribe's plays.

Physics

One unit.

The candidate will be expected to be familiar with the fundamental principles of Physics. A sufficiently extended treatment of the subject will be found in any of the principal text-books now in use in secondary schools, such, for instance, as Milliken and Gale, Carhart and Chute, Hoadley, Mann, and Twiss.

It is furthermore very desirable for the student to have received training in laboratory work; but for the present no laboratory work will be required.

Chemistry

One unit. The knowledge gained, if elementary, should be comprehensive and exact, including facts and laws. Laboratory work, emphasizing descriptive chemistry is necessary and notes of this work must be presented. Much attention should be given to solution of problems.

Biology

One unit. Under this one head are grouped the subjects of botany, zoölogy, and physiology. The one unit may be composed of a single subject or of any combination of two. Laboratory exercises or field work equal in time at least to that given to text-book and lecture is essential. In offering subject for credit the names of the text-books used should be given.

Physiography

One-half unit. This subject, otherwise known as physical geography, must have been pursued as a special subject and not as a part of the earlier study of general geography, and a standard text-book dealing with the subject solely must have been used.

Drawing

One unit. Either free-hand or mechanical drawing, or both, may be offered. Specimens of the work done must be presented, properly certified by the instructor, with a statement of the length of time taken in the course which they represent.

Shop-Work

One unit. The work done must usually have been of the systematic kind prescribed in courses of manual training.

CONDITIONS

No applicant with more than three entrance conditions will be admitted as a regular student. Conditions must be partly removed before the second year, and wholly before the third.

SCHOLARSHIPS

A limited number of scholarships are offered in the School of Mines. These scholarships entitle the holders to free tuition. For information concerning the conditions under which they are awarded apply to the Secretary of the University or the Dean of the School of Mines.

TUITION AND FEES

The tuition covers all fees except those specially mentioned below, and must be paid, with all current fees, upon registration, before name can be entered on class rolls.

Matriculation Fee (at entrance only).....	\$	5.00
Tuition, Fall Term		40.00
Tuition, Other Terms		35.00
Tuition per year, if paid in advance (except Freshman Year)		105.00
Tuition, Freshman year (four terms), if paid in advance.....		140.00
Chemistry, each course	Per Term	5.00
Physics	" "	5.00
Engineering Laboratory	" "	5.00
Assaying, (Fire)	" "	10.00
Metallurgical Laboratory }	Fall Term	5.00
	Winter and Spring Term, each	10.00
Mineralogical Laboratory	Per Term	3.00
Surveying (Summer Course)		10.00
Special Laboratory Work	Fees by arrangement	
Saturday Courses	Per Term	5.00
Spring Trip, Junior Year, Three Weeks.....	Estimated	75.00
Breakage Deposit for all students taking laboratory work.....		10.00
(Any balance remaining will be returned.)		
Diploma		5.00

DEGREES

The degrees conferred upon those satisfactorily completing courses offered are, respectively:

Engineer of Mines (E. M.), Metallurgical Engineer (Met. E.), Geological Engineer (Geol. E.), Ceramic Engineer (Cer. E.).

THESIS

A thesis is required of every candidate for degree. The thesis subject, together with an outline of the work proposed, must be approved by the head of the department in which the student is classified, not later than January 15th preceding commencement; and when so approved will be assigned him on a blank furnished for the purpose. A memorandum of this assignment must be filed in the office of the Dean.

The thesis in the proposed final form should be submitted to the Professor in charge at least two weeks prior to commencement.

The results obtained and the thesis prepared in connection with a regularly assigned thesis subject are the property of the University and no part of the thesis may be published without the consent of the Chancellor.

COURSES IN THE SCHOOL OF MINES

In order to retain the advantages of the elective system, whereby the student may choose his work along the line for which he seems best fitted, and at the same time to be certain that every man shall have a well-rounded course, the following group system has been adopted for regular undergraduate students.

The first two years' work is common to all courses. At the beginning of the third year, the student elects between Mining, Metallurgy, Geology and Ceramics, although there is little difference for the first two terms of that year; at the beginning of the spring term of the third year, there is further choice between metal-mining, coal-mining, and the mining of oil and gas, and between general metallurgy and the metallurgy of iron and steel. The work of the fourth or Senior year is, of course, quite different in the different groups.

It will be noted that the course in Surveying is given in the summer term of the Freshman year. This leaves two full summers for the practical work in mine, mill or smelter, or in the oil field according to the option chosen by the student. This practical or cooperative work is a very important feature of the course, and is required in all cases.

COURSE IN MANAGEMENT

Recognizing that, in a four-years' course in mining, metallurgy or ceramics, the student cannot expect to get more than the fundamentals of the profession; and further, that there is need for men trained along managerial lines, a fifth or post-graduate year is offered, leading to

the degree of Master of Science, with the idea that men taking this course will be fitted for work as executives.

Each application for admission to the course in Management will be decided upon its own merits. In general, however, graduation from a recognized technical school, supplemented by at least one year's practical work, will be necessary for admission.

A further description of this course will be found on page 28.

SHORT COURSES

The following short courses have been arranged for practical men who cannot afford the time to take a regular course:

1. For practical miners who desire to prepare for examination for fire-bosses;
2. For fire-bosses who wish to secure a mine foreman's certificate;
3. For those desiring to prepare for the mine inspector's examination;
4. For mine electricians.

Further description will be found on page 28.

Those who satisfactorily complete any of these courses will receive certificates of proficiency.

Similar short courses can be arranged in Oil and Gas Mining, Metallurgy and Ceramics at any time that a sufficient number of applications are received.

An evening course in Metallography, offered the past year, has been very successful, and this work will be continued.

An evening course in the Production of Oil and Gas has been arranged.

EXTENSION WORK

Upon request, a number of evening classes, covering the same ground as that covered on Saturday afternoons, were organized in mining towns in the district. This work will be extended during the coming year.

OUTLINE OF COURSES

Group I—Mining. Leads to degree of Engineer of Mines.

Option (a), General Mining.

Option (b), Coal Mining.

Option (c), Oil and Gas Mining.

Group II—Metallurgy. Leads to degree of Metallurgical Engineer.

Option (a), General Metallurgy.

Option (b), Metallurgy of Iron and Steel.

Group III—Geology. Leads to degree of Geological Engineer.

Group IV—Ceramics. Leads to degree of Ceramic Engineer.

FRESHMAN YEAR

REQUIRED IN GROUPS I, II, III, IV.

FALL TERM

No.	Subject	Class	Lab.	Credits	See Page
Math. 5	Plane Trigonometry	3	0	3	31
Math. 6	Advanced Algebra	2	0	2	31
Chem. 4	Inorganic Chemistry	2	6	4	32
Gr. 1	Mechanical Drawing	0	3	1	33
M. E. 1-a	El. Mechanical Lab.	1	6	3	35
En. 4	English Composition	4	0	4	29
Ger. or Rom.	German, French or Spanish	3	0	3	30
Phys. Ed. 1	Physical Education	0	3	1	..
		15	18	21	..

WINTER TERM

Math. 7	Analytic Geometry	5	0	5	31
Chem. 5	Inorganic Chemistry	2	6	4	32
Gr. 2	Mechanical Drawing	0	3	1	33
M. E. 2-a	El. Mechanical Lab.	1	6	3	35
En. 5	English Composition	4	0	4	29
Ger. or Rom.	German, French or Spanish	3	0	3	30
Phys. Ed. 2	Physical Education	0	3	1	..
		15	18	21	..

SPRING TERM

Math. 4	Spherical Trigonometry	2	0	2	31
Math. 8	Analytic Geometry	5	0	5	31
Chem. 6	Inorganic Chemistry	2	6	4	32
Gr. 3	Mechanical Drawing	0	6	2	33
M. E. 3-a	El. Mechanical Lab.	1	6	3	35
En. 6	English Composition	2	0	2	29
Ger. or Rom.	German, French or Spanish	3	0	3	30
Phys. Ed. 3	Physical Education	0	3	1	..
		15	21	22	..

SUMMER TERM

C. E. 22	Surveying—50 hours per week for 10 weeks—20 credits. (See page 34).
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SOPHOMORE YEAR

REQUIRED IN GROUPS I, II, III, IV.

FALL TERM

No.	Subject	Class	Lab.	Credits	See Page
Math. 9	Calculus	4	0	4	31
Chem. 20	Qual. and Quant. Analysis	1	6	3	32
Phys. 11	Physics	4	3	5	32
Gr. 4	Mech. Sketching & Drafting	0	6	2	33
M. E. 4-a	El. Mechanical Lab.	1	3	2	35
Geol. 1	General Geology	3	0	3	39
Miner. 2	Crystallography and Mineralogy	2	6	4	38
Phys. Ed. 4	Physical Education	0	3	1	..
		15	27	24	..

WINTER TERM

Math. 10	Calculus	4	0	4	31
Chem. 21	Qual. and Quant. Analysis	1	6	3	32
Phys. 12	Physics	4	3	5	32
Gr. 5	Descriptive Geometry	2	6	4	33
Geol. 2	Stratigraphical Geology	3	0	3	39
Miner. 3	Mineralogy	2	6	4	38
Phys. Ed. 5	Physical Education	0	3	1	..
		16	24	24	..

SPRING TERM

Chem. 22	Qual. and Quant. Analysis	1	6	3	32
Phys. 13	Physics	4	3	5	32
Mech. 1	Analytic Mechanics	5	0	5	33
Geol. 3	Structural & Field Geology	3	6	5	39
Miner. 4	Mineralogy & Lithology	2	6	4	38
Phys. Ed. 6	Physical Education	0	3	1	..
		15	24	23	..

JUNIOR YEAR, GROUP I.

FALL TERM

No.	Subject	Class	Lab.	Credits	Option	See Page
Chem. 40	Organic Chemistry	2	6	4	c	32
Mech. 2	Mechanics of Material	5	0	5	a, b, c	33
Mech. 3	Mechanical Laboratory	0	6	2	a, b, c	34
Mech. 4	Graphic Statics	1	6	3	a, b, c	34
Ec. Geol. 1	Economic Geology	3	0	3	a, b, c	39
Ec. Geol. 16	Geology of Oil and Gas	2	0	2	c	40
Ec. Geol. 19	Oil and Gas Laboratory	0	3	1	c	40
Ec. Geol. 22	Seminar in Oil and Gas	1	0	1	c	40
Mine 1	Principles of Mining	3	0	3	a, b, c	41
Met. 1-a	General Metallurgy	3	0	3	a, b	44
Met. 1-b	Metallurgical Laboratory	0	6	2	a, b	45
Met. 4	Ore Dressing	3	0	3	a, b	45

WINTER TERM

Chem. 41	Organic Chemistry	2	6	4	c	32
E. E. 2	Applied Electricity	2	3	3	a, b, c	36
Ec. Geol. 2	Economic Geology	3	0	3	a, b, c	39
Ec. Geol. 17	Geology of Oil and Gas	2	0	2	c	40
Ec. Geol. 20	Oil and Gas Laboratory	0	9	3	c	40
Ec. Geol. 23	Seminar in Oil and Gas	1	0	1	c	40
Mine 2	Principles of Mining	3	0	3	a, b, c	41
Mine 11	Underground Surveying	2	3	3	a, b	42
Mine 26	Inspection Trips	..	..	1	a, b, c	43
Met. 2-a	General Metallurgy	3	0	3	a, b	44
Met. 2-b	Metallurgical Laboratory	0	6	2	a, b	45
Met. 5	Ore Dressing	3	0	3	a, b	45
Ec. 3-e	Economic Theory	3	0	3	a, b, c	36

SPRING TERM

Chem. 42	Organic Chemistry	2	6	4	c	32
M. E. 4	Prime Movers	2	3	3	a, b, c	36
S. E. 1	Hydro-Mechanics and Hy- draulics	4	0	4	a, b, c	36
S. E. 2	Hydraulic Laboratory	0	3	1	a, b, c	36
Ec. Geol. 3	Economic Geology	3	0	3	a, b, c	39
Ec. Geol. 18	Geology of Oil and Gas	2	0	2	c	40
Ec. Geol. 21	Oil and Gas Laboratory	0	9	3	c	40
Ec. Geol. 24	Seminar in Oil and Gas	1	0	1	c	40
Mine 3	Ore Mining Methods	3	0	3	a	41
Mine 4	Coal Mining Methods	2	0	2	b	41
Mine 5	Mine Gases and Explosions	3	0	3	b	41
Met. 3-a	General Metallurgy	3	0	3	a, b	44
Met. 3-b	Metallurgical Laboratory	0	6	2	a, b	45
Met. 6	Ore Dressing (Stamp- Milling)	3	0	3	a	45
Met. 23	Ore Dressing (Coal Washing)	3	0	3	b	46
Met. 32	Inspection Trips	..	..	1	a	46

Field Trip—3 weeks Spring Vacation (see page 47).

SENIOR YEAR, GROUP I.

FALL TERM

No.	Subject	Class	Lab.	Credits	Option	See Page
C. E. 23	Masonry, Concrete, etc.	3	6	5	a, b, c	35
Mine 6	Gas Analysis	1	6	3	b, c	41
Mine 18	Mining Costs and Mine Management	3	0	3	a, b, c	42
Mine 23	Seminar	1	0	1	a, b, c	43
Mine 27	Production of Oil and Gas	2	6	4	c	43
Mine 30	Mining Engineering	..	..	3	a, b	43
Met. 24	Fire Assaying	1	6	3	a, b	46
*Electives to total 22 credits						

WINTER TERM

Mine 7	Mine Ventilation	2	6	4	b	41
Mine 9	Power Transmission	2	0	2	a, b, c	42
Mine 12	Mine Plant Design	1	6	3	a, b	42
Mine 16	Coke Manufacture	2	0	2	b	42
Mine 19	Mining Costs and Mine Management	3	0	3	a, b, c	42
Mine 21	Mining Law	2	0	2	a, b, c	43
Mine 24	Seminar	1	0	1	a, b, c	43
Mine 28	Production of Oil and Gas	2	6	4	c	43
Mine 31	Mining Engineering	..	..	3	a, b	43
*Electives to total 22 credits						

SPRING TERM

Ec. 46	Contracts and Specifications	3	0	3	a, b, c	38
Mine 13	Mine Plant Design	1	6	3	a, b	42
Mine 14	Projection of Workings	1	6	3	b	42
Mine 15	First Aid and Mine Rescue Work	0	6	2	a, b, c	42
Mine 17	Coke Manufacture	2	0	2	b	42
Mine 20	Mine Valuation	2	0	2	a, b, c	43
Mine 22	Mining Law	2	0	2	a, b, c	43
Mine 25	Seminar	1	0	1	a, b, c	43
Mine 29	Examination of an Oil or Gas Property	..	..	5	c	43
Mine 32	Mining Engineering	..	..	3	a, b	43
Mine 33	Petroleum Refining	..	..	3	c	43
*Electives to total 22 credits						

*It is suggested that students elect Ec. 13, 16, 19 or Ec. 21, 24, 27.

JUNIOR YEAR, GROUP II.

FALL TERM

No.	Subject	Class	Lab.	Credits	See Page
Chem. 10	Advanced Inorganic Chemistry	2	0	2	32
Mech. 2	Mechanics of Materials	5	0	5	33
Mech. 3	Mechanical Laboratory	0	6	2	34
Mech. 4	Graphic Statics	1	6	3	34
Mine 1	Principles of Mining	3	0	3	41
Met. 1-a	General Metallurgy	3	0	3	44
Met. 1-b	Metallurgical Laboratory	0	6	2	45
Met. 4	Ore Dressing	3	0	3	45
		..	..	23	..

WINTER TERM

Ec. 3-e	Economic Theory	3	0	3	36
Chem. 11	Advanced Inorganic Chemistry	2	0	2	32
E. E. 2	Dynamos and Motors	2	3	3	36
Mine 2	Principles of Mining	3	0	3	41
Mine 26	Inspection Trips	..	..	1	43
Met. 2-a	General Metallurgy	3	0	3	44
Met. 2-b	Metallurgical Laboratory	0	6	2	45
Met. 5	Ore Dressing	3	0	3	45
		..	..	20	..

SPRING TERM

Chem. 12	Advanced Inorganic Chemistry	2	0	2	32
M. E. 4	Prime Movers	2	3	3	36
S. E. 1	Hydromechanics and Hydraulics	4	0	4	36
S. E. 2	Hydraulic Laboratory	0	3	1	36
Mine 3	Ore Mining Methods	3	0	3	41
Met. 3-a	General Metallurgy	3	0	3	44
Met. 3-b	Metallurgical Laboratory	0	6	2	45
Met. 6 or 23	Ore Dressing	3	0	3	45
Met. 32	Inspection Trips	..	..	1	46
		..	..	22	..

Field Trip—3 weeks Spring Vacation (see page 47).

SENIOR YEAR, GROUP II.

FALL TERM

No.	Subject	Class	Lab.	Credits	See Page
Met. 7	Principles of Metallurgy	1	6	3	45
Met. 16	Metallurgy of Copper, Lead, the Minor Metals	4	0	4*	45
Met. 13	Metallurgy of Iron and Steel	4	0	4†	45
Met. 24	Assaying	1	6	3	46
Met. 36	Current Literature	1	0	1	46
	Electives in Metallurgy	..	..	5	..
	Other Electives	..	..	6	..
				22	..

WINTER TERM

Met. 8	Principles of Metallurgy	3	0	3	45
Met. 17	Metallurgy of Copper, Lead, the Minor Metals	4	0	4*	45
Met. 14	Metallurgy of Iron and Steel	4	6	6†	45
Met. 25	Assaying	0	6	2*	46
Met. 37	Current Literature	1	0	1	46
	Electives in Metallurgy	..	..	6	..
	Other Electives	..	..	6	..
				22	..

SPRING TERM

Ec. 46	Contracts and Specifications	3	0	3	38
Met. 9	Principles of Metallurgy	3	0	3	45
Met. 18	Metallurgy of Copper, Lead, the Minor Metals	4	0	4*	45
Met. 15	Metallurgy of Iron and Steel	4	0	4†	45
Met. 38	Current Literature	1	0	1	46
	Electives	..	..	11	..
				22	..

*Option (a) †Option (b)

It is suggested that students elect Ec. 13, 16, 19 or Ec. 21, 24, 27.

JUNIOR YEAR, GROUP III.

FALL TERM

No.	Subject	Class	Lab.	Credits	See Page
Mech. 2	Mechanics of Materials	5	0	5	33
Mech. 3	Mechanical Laboratory	0	6	2	34
Mech. 4	Graphic Statics	1	6	3	34
Ec. Geol. 1	Economic Geology	3	0	3	39
Min. 7	Petrography	1	6	3	39
Mine 1	Principles of Mining	3	0	3	41
Met. 1-a	General Metallurgy	3	0	3	44
Met. 1-b	Metallurgical Laboratory	0	3	1	45
		..	..	23	..

WINTER TERM

Ec. Geol. 2	Economic Geology	3	0	3	39
Min. 8	Petrography	1	6	3	39
Mine 2	Principles of Mining	3	0	3	41
Mine 11	Underground Surveying	2	3	3	42
Mine 26	Inspection Trips	..	..	1	43
Met. 2-a	General Metallurgy	3	0	3	44
Met. 2-b	Metallurgical Laboratory	0	6	2	45
		..	..	18	..

SPRING TERM

S. E. 1	Hydro-Mechanics and Hydraulics	4	0	4	36
S. E. 2	Hydraulic Laboratory	0	3	1	36
Ec. Geol. 3	Economic Geology	3	0	3	39
Min. 9	Petrography	1	6	3	39
Mine 3	Ore Mining Methods	3	0	3	41
Met. 3-a	General Metallurgy	3	0	3	44
Met. 3-b	Metallurgical Laboratory	0	6	2	45
		..	..	19	..

Field Trip—3 weeks Spring Vacation (see page 47).

SENIOR YEAR, GROUP III.

FALL TERM

No.	Subject	Class	Lab.	Credits	See Page
Pal. 1	Invertebrate Paleontology	2	6	4	39
Ec. Geol. 13	Seminar	1	0	1	40
Ec. Geol. 16	Geology of Oil and Gas	2	0	2	40
Mine 10	Placer Mining	2	0	2	42
	Electives in Economic Geology	..	..	6	..
	Other Electives	..	..	7	..
				22	..

WINTER TERM

Pal. 2	Invertebrate Paleontology	2	6	4	39
Ec. Geol. 14	Seminar	1	0	1	40
Ec. Geol. 17	Geology of Oil and Gas	2	0	2	40
Mine 21	Mining Law	2	0	2	43
	Electives in Economic Geology	..	..	6	..
	Other Electives	..	..	7	..
				22	..

SPRING TERM

Pal. 3	Invertebrate Paleontology	2	6	4	39
Ec. Geol. 15	Seminar	1	0	1	40
Ec. Geol. 18	Geology of Oil and Gas	2	0	2	40
Mine 22	Mining Law	2	0	2	43
Mine 20	Mine Valuation	2	0	2	43
	Electives in Economic Geology	..	..	5	..
	Other Electives	..	..	6	..
				22	..

JUNIOR YEAR, GROUP IV.

No.	Subject	Class	Lab.	Credits	See Page
Chem. 23	Advanced Quantitative Analysis	1	6	3	32
Mech. 2	Mechanics of Materials	5	0	5	33
Mech. 3	Mechanical Laboratory	0	6	2	34
Mech. 4	Graphic Statics	1	6	3	34
Ec. Geol. 1	Economic Geology	3	0	3	39
Mine 1	Principles of Mining	3	0	3	41
Cer. 1	Investigation & Testing of Clays	1	6	3	47
Cer. 4	Manufacture of Clay Products	2	0	2	47
		..	..	24	..

WINTER TERM

Ec. 3-e	Economic Theory	3	0	3	36
Chem. 24	Advanced Quantitative Analysis	1	6	3	32
E. E. 2	Dynamos and Motors	2	3	3	36
Ec. Geol. 2	Economic Geology	3	0	3	39
Mine 2	Principles of Mining	3	0	3	41
Mine 26	Inspection Trips	..	..	1	43
Cer. 2	Investigation & Testing of Clays	1	6	3	47
Cer. 5	Manufacture of Clay Products	2	0	2	47
		..	..	21	..

SPRING TERM

Chem. 25	Advanced Quantitative Analysis	1	6	3	32
M. E. 4	Prime Movers	2	3	3	36
S. E. 1	Hydromechanics and Hydraulics	4	0	4	36
S. E. 2	Hydraulic Laboratory	0	3	1	36
Ec. Geol. 3	Economic Geology	3	0	3	39
Mine 4	Coal Mining Methods	2	0	2	41
Cer. 3	Investigation & Testing of Clays	1	6	3	47
Cer. 6	Manufacture of Clay Products	2	0	2	47
Cer. 9	Inspection Trips	..	..	1	47
		..	..	22	..

Field Trip—3 weeks Spring Vacation (see page 47).

SENIOR YEAR, GROUP IV.

FALL TERM

No.	Subject	Class	Lab.	Credits	See Page
Met. 1-a	General Metallurgy	3	0	3	44
Met. 1-b	Metallurgical Laboratory	0	3	1	45
Cer. 10	Pottery and Glazes	2	0	2	47
Cer. 13	Ceramic Laboratory	0	15	5	47
Cer. 17	Seminar	1	0	1	47
Cer. 20	Plant Design	1	6	3	47
	*Electives	..	..	7	..
				22	..

WINTER TERM

Met. 2-a	General Metallurgy	3	0	3	44
Met. 2-b	Metallurgical Laboratory	0	3	1	45
Cer. 11	Pottery and Glazes	2	0	2	47
Cer. 14	Ceramic Laboratory	0	15	5	47
Cer. 18	Seminar	1	0	1	47
Cer. 21	Plant Design	1	6	3	47
	*Electives	..	..	7	..
				22	..

SPRING TERM

Ec. 46	Contracts and Specifications	3	0	3	38
Met. 3-a	General Metallurgy	3	0	3	44
Met. 3-b	Metallurgical Laboratory	0	3	1	45
Cer. 12	Pottery and Glazes	2	0	2	47
Cer. 15	Ceramic Laboratory	0	15	5	47
Cer. 19	Seminar	1	0	1	47
	*Electives	..	..	7	..
				22	..

*It is suggested that students elect Ec. 13, 16, 19 or Ec. 21, 24, 27.

POST-GRADUATE YEAR

(See page 15 for announcement.)

In this course the individual student will, necessarily, be allowed some latitude in his choice of work, depending upon his training and experience, and depending also upon whether he wishes to confine his investigation work to mines or mills of the types found in this district, or to work further afield.

In the fall term the class-room work will be mainly in elementary psychology, sociology and economics, and the theory of management, considerable time being allowed the student to study conditions and systems in the mines and mills of the Pittsburgh region.

The winter term is spent entirely in the field, each man being given an outline of work to follow, so that he may be able to ascertain what are the difficulties which confront the average superintendent or manager, and how these are met. He is required to make a weekly report to the school, in order that his work may be closely followed up and proper suggestions made to him.

At the beginning of the spring term he returns to the school, where he takes more advanced economics, etc., and works up into proper shape for presentation the data gathered during the fall and winter terms.

As indicated above, this schedule is variable, the endeavor being to fit the course to the individual student, rather than the student to the course. Those interested should write to the Dean for further information.

SHORT COURSES

(See page 16 for announcement.)

1. Course arranged for men desirous of a fire-boss' certificate includes the following subjects:

- Mine Ventilation,
- Mining Law,
- Mine Gases and Explosions,
- Mine Accidents and their Prevention.

2. Course arranged for men desirous of a foreman's certificate includes the following subjects:

- Methods of Working,
- Mine Drainage and Pumping,
- Haulage and Hoisting,
- Recovering Coal Mines after Explosions and Fires.

3. Course arranged for men desirous of a State Mine Inspector's certificate includes the following subjects:

- Engines and Boilers,
- Principles of Chemistry,
- Elementary Electricity,
- Mine Economics or
- Compressed Air in Mining.

4. Course arranged for men desirous of a position as mine electrician includes the following subjects:

- Electricity in Mines,
- Elementary Electricity,
- Engines and Boilers,
- Mine Gases and Explosions or
- Mine Accidents and their Prevention.

The idea in arranging these courses is that men may take them in their proper order. For instance, one who has taken Course No. 1 may

continue by taking Course No. 2 and upon its completion Course No. 3, thus in two years' time fitting himself as an applicant for a State Mine Inspectorship. Course No. 4 is arranged solely for men desiring a theoretical, as well as a practical, knowledge of Electricity.

Saturday afternoons throughout the scholastic year have been set aside for the purpose of meeting men entering upon any of these four courses. This day has been selected as it offers better opportunity for men to leave their work at the mine and reach the city. With this arrangement one week's time is given to the preparation of the work, and Saturday afternoon devoted to recitations and explanations.

Wherever the applicant for any course wishes to substitute a subject from another course, permission may be had by presenting the matter in writing to the Dean of the School.

This work is also given to evening classes in mining towns of the district. Persons interested should inquire of the Dean concerning possible arrangements.

DEPARTMENTS OF INSTRUCTION

The following include the required courses in the School of Mines, together with such electives as it was thought might be chosen by students of the School. For further studies which are open as electives see the general catalog of the University.

English Language and Literature

4 and 5. ENGLISH COMPOSITION

Dr. SNOW. Fall and Winter Terms, 4 credits each term.

A study of the principles of composition, written and oral, with especial reference to exposition. Practice in writing and speaking; analysis of specimens of technical and scientific exposition. Text-book: Earle's *Technical Writing*.

Required of all Freshmen.

6. ENGLISH COMPOSITION

Dr. SNOW. Spring Term, 2 credits.

A continuation of courses 4 and 5, the practice in oral composition being discontinued.

Required of all Freshmen.

7. ARGUMENTATION AND DEBATING

Professor Gibbs and Mr. Fall and Winter Terms, each 3 credits.

The theory of argumentation, with practical exercises in brief-drawing and the composition and the delivery of forensics.

Elective for students who have taken Courses 1, 2, 3, or 4, 5, 6.

15. ENGLISH LITERATURE

Professor Gibbs. Winter Term, 3 credits.

A study of selected masterpieces representing the successive periods of English literature, with a text-book to furnish a historical background and connections.

Elective for students who have taken Courses 1, 2, 3, or 4, 5, 6.

German Language and Literature

1, 2, 3. ELEMENTARY GERMAN

Professor Berger. Fall, Winter and Spring Terms, 3 credits each term.

Elements of grammar and the reading of easy texts. Vos, *Essentials of German*; Hewitt's *German Reader*; Simple lyrics and ballads memorized. Gerstaecker, *Germelhausen*; Baumbach, *Der Schwiegersohn*.

Open to Freshmen who have satisfied requirements for admission by offering French or Latin if they wish to take up German as the required modern language.

4, 5, 6. INTERMEDIATE COURSE

Professor Berger. Fall, Winter and Spring Terms, 3 credits each term.

Review of Grammar. Drill in translating from English into German and practice in conversation. Memorizing of simple prose and poetry. Wesselhoeft: *German Exercises*. Wenckebach: *German Composition*. Wildenburch: *Des edle Blut*. Gerstaecker: *Irrfahrten*. Hatfield: *German Lyrics and Ballads*.

Classical German Authors. Selections from the following lists of texts: Schiller: *Maria Stuart*. Goethe: *Hermann und Dorothea*. Lessing: *Minna von Barnhelm*. German is used extensively in conducting class work.

Required of all Freshmen satisfying entrance requirements in German who elect to continue it.

7, 8, 9. TECHNICAL GERMAN

Fall, Winter and Spring Terms, 3 credits each term.

Syntax. Prose Composition, conversation. Freytag: *Soll und Haben*, *Aus dem Jahrhundert des grossen Krieges*. Whitefield and Kaiser: *A Course of Commercial German*.

Elective for students who have taken previous courses.

Romance Languages and Literature

1, 2, 3. ELEMENTARY FRENCH

Professor Harry. Fall, Winter and Spring Terms, 3 credits each term.

Grammar composition and easy reading, with thorough drill in pronunciation and practice in speaking.

Open to Freshmen who have satisfied requirements for admission by offering German or Latin, if they wish to pursue French as the required modern language.

4, 5, 6. INTERMEDIATE FRENCH

Professor Harry. Fall, Winter and Spring Terms, 3 credits each term.

Extensive reading in selected works of Modern French writers. Fraser and Squair's Grammar completed. Advanced prose composition. French conversation. The following texts are read: Daudet, *Contes Choisis*; Maupassant, *Contes*; Coppee, *On rend l'Argent*; Augier, *Le Gendre de M. Poirer*; George Sand, *La Mare au Diable*; Canfield; French Lyrics.

Required of all Freshmen satisfying entrance requirements in French who elect to continue it.

7, 8, 9. TECHNICAL FRENCH

Professor Harry. Fall, Winter and Spring Terms, 3 credits each term.

Herdler's *Scientific Reader* and other works of similar character will be read. The purpose of this course is to enable students to use Scientific French readily and is primarily designed for students in Engineering courses who have a good reading knowledge of ordinary French prose.

30, 31, 32. ELEMENTARY SPANISH

Dr. Boyce. Fall, Winter and Spring Terms, 3 credits each term.

Hill's and Ford's *Spanish Grammar*, reading, composition, conversation. Bransby's *Spanish Reader*, Selgas, *La Mariposa Blanca*; Galdos, *Dona Perfecta*; Tamayo, *Lo Positivo*; Giese's *Spanish Anecdotes*.

35, 36, 37. COMMERCIAL SPANISH

Dr. Boyce. Fall, Winter and Spring Terms, 3 credits each term.

Reading of Commercial Spanish. Commercial correspondence. Conversation. The vocabulary of every day life is emphasized.

40, 41, 42. ELEMENTARY ITALIAN

Dr. Pierucci. Fall, Winter and Spring Terms, 3 credits each term.

Elementary grammar, dictation, reading, memorizing, conversation, and easy composition. Motti's *Elementary Italian Grammar*. Cattaneo, *Italian Reader*. DeAmicis, *Cuore*. Other selections from modern authors will be assigned by the instructor.

43, 44, 45. ITALIAN, INTERMEDIATE COURSE

Dr. Pierucci. Fall, Winter and Spring Terms, 3 credits each term.

Study of the Italian Grammar in Italian. Conversation and advanced prose composition. Italian literature of the XVIII and XIX centuries. Selected readings and brief lectures in Italian. Manzoni, *I Promessi Sposi*, will be read in full.

Open to students who have taken the course in Elementary Italian.

Mathematics

4. SPHERICAL TRIGONOMETRY

Professor Frost.

Spring Term, 2 credits.

Theory and application to solution of right and oblique spherical triangles.

Required of all Freshmen.

5. PLANE TRIGONOMETRY

Mr. Dyche and Mr. Albert.

Fall Term, 3 credits.

The subjects treated are the functions of angles, goniometry, trigonometric equations, solution of right and oblique triangles. Special emphasis is placed upon solution of examples of all kinds involving both theory and practical applications.

Required of all Freshmen.

6, 7, 8, 9, 10.

Professor Wenrich, Mr. Dyche and Mr. Albert.

Freshman Year:

Fall Term, 2 credits; Winter Term, 5 credits; Spring Term, 5 credits.

Sophomore Year:

Fall Term, 4 credits; Winter Term, 4 credits.

This is a course in Mathematics for students in Engineering and Applied Science as presented in Woods and Bailey's Text.

Advanced Algebra, Analytic Geometry, Differential and Integral Calculus are combined in this one Treatise.

The course extends throughout the Freshman year and terminates at the end of the second term in the Sophomore year.

Required in all Groups.

Chemistry

4, 5, 6. GENERAL INORGANIC CHEMISTRY

Professors Scholes and Clark; Messrs. Clark and Thomas.

Fall, Winter and Spring Terms, 4 credits each term.

A study of the metals and non-metals, principles, theories, and calculations. This course is intended for students who have not had chemistry in preparatory schools. Two lectures and two three-hour laboratory periods per week. A recitation is conducted at the beginning of each laboratory period.

Required of all Freshmen.

10, 11, 12. ADVANCED INORGANIC CHEMISTRY

Fall, Winter and Spring Terms, 2 credits each term.

This course supplements the work in courses 1, 2, and 3; or 4, 5, and 6; or 7, 8, and 9, which are pre-requisite. It deals specially with the modern theories of chemistry. Two lectures per week.

Required in Group II.

20, 21, 22. QUALITATIVE AND QUANTITATIVE ANALYSIS

Professors Silvermann, Pratt and Corliss and Mr. Shumaker.

Fall, Winter and Spring Terms, 4 credits each term.

A study of qualitative tests applied in detection of the more common elements and compounds followed by methods for separation of the various elements from each other. On completion of this work, the student is given instruction and practice in the exact or quantitative determination of some of the above elements by both gravimetric and volumetric methods. One lecture, one recitation and two three-hour laboratory periods per week. Pre-requisites: 1, 2, and 3; or 4, 5, and 6; or 7, 8, and 9.

Required of all Sophomores.

23, 24, 25. QUANTITATIVE ANALYSIS

Professors Silvermann, Pratt and Corliss, and Mr. Shumaker.

Fall, Winter and Spring Terms, 4 credits each term.

A more advanced course including analysis of ores, manufactured products, etc., for the purpose of preparing the student for work in industrial laboratories. One lecture, one recitation and two three-hour laboratory periods per week. Pre-requisites: 20, 21, and 22.

Required in Group IV.

40, 41, 42. ORGANIC CHEMISTRY

Professors Kohman, Shively and Clayton, and Messrs. Uhlinger and Hobbs.

Fall, Winter and Spring Terms, 4 credits each term.

Chemistry of the Compounds of Carbon.

Required in Group I-C.

Physics

11, 12, 13. GENERAL PHYSICS

Professor Bishop and Mr. Morris.

Fall, Winter and Spring Terms, 5 credits each term.

First term, mechanics and heat; second term, electricity; third term, sound and light. In this course the calculus is extensively employed and special attention is given to the physical interpretation of mathematical equations.

A series of twelve lectures on the precision of measurements is given in connection with the laboratory work. Special attention is given in the laboratory to the method of the experiment and to the precision of the results.

Concurrent with Mathematics 8 and 10.

Required of all Sophomores.

Graphics

1. MECHANICAL DRAWING.

Mr. Lambie.

Fall Term, 1 credit.

The care and use of drafting instruments, instrument exercises, geometrical constructions, lettering, shading, exercises in drawing to scale, and dimensioning.

Three hours per week in drafting room. Freshman year.

2. MECHANICAL DRAWING

Mr. Lambie.

Winter Term, 1 credit.

Orthographic projections, rotation of objects, oblique projections, intersections, and development of surfaces.

Three hours per week in drafting room. Freshman year.

Pre-requisite: Graphics 1.

3. MECHANICAL DRAWING

Mr. Lambie.

Spring Term, 2 credits.

Isometric drawing and dimensioning, sectioning, and machine drawing.

Six hours per week in drafting room. Freshman year.

Pre-requisite: Graphics 2.

4. MECHANICAL SKETCHING AND DRAFTING

Mr. Lambie.

Fall Term, 2 credits.

Graded exercises in the measuring and sketching of mechanical constructions, and the subsequent detail drafting of the same.

Six hours per week in drafting room. Sophomore year.

Pre-requisite: Graphics 3.

5. DESCRIPTIVE GEOMETRY

Mr. Lambie.

Winter Term, 4 credits.

A critical study of the science of representing by drawing. The location of points, lines, planes, single curved surfaces, surfaces of revolution, and warped surfaces, with their relations to each other; tangent lines and planes; intersection of surfaces; shades, shadows, and perspective.

Two lectures and six hours in drafting room per week. Sophomore year.

Pre-requisites: Graphics 4; Mathematics 7.

Mechanics

1. ANALYTIC MECHANICS

Professor Wenrich.

Spring Term, 5 credits.

This subject comprises among its topics the composition and resolution of forces, the center of gravity, the moment of inertia, radius of gyration, laws of friction and of motion, projectiles, impact, machines, work, and energy. The solution of numerous problems in application of formulas is constantly required.

Five recitations and lectures per week. Sophomore year.

Pre-requisite: Mathematics 10.

2. MECHANICS OF MATERIALS

Professor Stewart.

Fall Term, 5 credits.

The resistance and elasticity of materials. The action of beams under various conditions of fixity and loading; strength of columns and shafts; combined stresses; resilience of materials; etc.

Five recitations and lectures per week. Junior year.

Pre-requisite: Mechanics 1.

3. MECHANICAL LABORATORY

Professor Richardson.

Fall Term, 2 credits.

The experimental study of the physical properties of the materials of construction, such as iron and steel, wood, brick, stone, cement, and concrete.

Six laboratory-hours per week, Junior year.

To be taken concurrently with Mechanics 2.

4. GRAPHIC STATICS

Mr. Bankson.

Fall Term, 3 credits.

The solution of problems in which the stresses in frame work, beams, roof and bridge trusses are ascertained by graphical methods. Methods for dead, snow, wind, and live loads.

One lecture and six hours drawing per week. Junior year.

Pre-requisites: Graphics 1; Mechanics 1.

Civil Engineering

22. SURVEYING

Mr.....

Summer Term, 20 credits.

The course includes

I. PRELIMINARY SURVEYING.—Pacing; ranging; preliminary location of mining claims and filing of notice of location; adjustment of Locke level; topographical survey of mining claim by pacing and hand level.

II. LAND SURVEYING.—Adjustment of compass; subdivision of land; farm survey; city survey; adjustment of solar attachments; official survey of mining claim.

III. TOPOGRAPHICAL SURVEYING.—Adjustment of transit; repetition traverse; azimuth traverse; adjustment of plane table instrument; topographical survey with plane table; topographical survey with transit and stadia; tying up of topographical survey to triangulation system.

IV. GOEDETIC SURVEYING.—Measurements of base line; triangulation, including computations and adjustment of quadrilateral; adjustment of engineers' level; determination of elevation of bench marks and triangulation points by levelling; observation on Polaris with transit for determination of true azimuth.

V. RAILROAD SURVEYING.—Reconnaissance with clinometer and pocket compass; preliminary survey with transit, chain and engineers' level, topography by pacing and hand level; permanent location with transit, steel tape, and engineers' level; computation of simple and compound curves; setting curve and line stakes with transit and steel tape; profile levelling; plotting on profile sheet and establishment of grade; cross-sectioning; computation of cuts and fills; computing and laying in turnouts, frogs, switches and Y-junction curves.

Maps are required to be made of the mining claim pacing survey, the mining claim official survey, the azimuth and repetition traverses, the farm survey, the city survey, the stadia survey, and the railroad survey.

The class is divided into squads, each man being required to do every kind of work with every instrument used, make a full set of notes of the work done by his squad, and from those notes make the maps in the drawing room.

50 hours per week. Required of all students in the School of Mines.

23. ELEMENTS OF MASONRY AND CONCRETE CONSTRUCTION

Mr. Lambie.

Fall Term, 5 credits.

This is an elementary course, designed to meet the needs of mining engineers. It comprises a brief outline of the theory, and a study of practical construction of: reinforced concrete beams and slabs, masonry and concrete foundations, retaining walls and arches. The laboratory exercises include the testing of cements, sand, gravel, mortar, and concrete specimens.

Three lectures, and six laboratory hours per week. Required in Group 1.

Mechanical Engineering

(1a) ELEMENTARY MECHANICAL LABORATORY

Mr. Weber and Assistants.

Fall Term, 3 credits.

The elementary study of casting design from the standpoint of moulding and founding. The student is required to mould a graded set of patterns, run off heats, and cast a number of representative test specimens from various metals. The lecture and recitation work covers the study of the properties of castings and the production of same on a commercial scale. Inspection trips are made to local foundries.

One lecture or recitation and six hours elementary laboratory work per week. Freshman year.

(2a) ELEMENTARY MECHANICAL LABORATORY

Mr. Weber and Assistants.

Winter Term, 3 credits.

The elementary study of the treatment and properties of wrought iron, soft steel, and carbon tool steel. The student is required to forge and machine a number of representative test specimens which will bring out the characteristics and strength of materials. The lecture and recitation work covers the study of the properties of wrought metals, and the working and forging of same on a commercial scale. Inspection trips are taken to local industrial plants.

One lecture or recitation and six hours elementary laboratory work per week. Freshman year.

(3a) ELEMENTARY MECHANICAL LABORATORY

Mr. Weber and Assistants.

Spring Term, 3 credits.

Machine elements and structural details are prepared and tested, and the results reported. The lecture and recitation work includes the discussion of the results of laboratory tests and the study of the elementary features of machine and structural design.

One lecture or recitation and six hours elementary laboratory work per week. Freshman year.

(4a) ELEMENTARY MECHANICAL LABORATORY

Mr. Weber and Assistants.

Fall Term, 2 credits.

A continuation of 3a together with the heat treatment of various carbon and high speed tool steels, case-hardening, etc.

One lecture or recitation and three hours elementary laboratory work per week. Sophomore year.

(5a) PROCESSES OF MANUFACTURE

Mr. Weber.

Winter Term, 3 credits.

The study of up-to-date processes of manufacture, by means of visits of inspection each alternate week accompanied with lectures and reference and text book study.

Two lectures or recitations and three hours visiting or reporting per week. Sophomore year.

4. PRIME MOVERS

Professor Richardson.

Winter Term, 3 credits.

A brief study of the construction and operation of steam boilers, engines and turbines; and of gas engines and producers.

Two lectures and three laboratory hours per week. Junior year, Groups I, II and IV.

Pre-requisites: Mechanics 1; Physics 13.

Electrical Engineering

2. APPLIED ELECTRICITY

Professor Harris.

Winter Term, 3 credits.

This is a short course designed to meet the requirements of those not specializing in Electrical Engineering.

Two lectures and recitations and three hours laboratory per week. Junior year, Groups I, II and IV.

Pre-requisite: Physics 13.

SANITARY ENGINEERING

1. HYDRO-MECHANICS AND HYDRAULICS

Mr. LAMBIE

Spring Term, 4 credits.

The equilibrium and pressure of liquids; the motion and work of fluids; the flow of water through orifices, over weirs, in pipes, and in canals; measurement of water power; and hydraulic machinery.

Four recitations and lectures per week. Junior year.

Pre-requisites: Mechanics 1, Mathematics 10.

2. HYDRAULIC LABORATORY

Professor Richardson

Spring Term, 1 credit.

The experimental study of the flow of water through pipes, nozzles, orifices, and over weirs. Capacity and efficiency tests of hydraulic turbine pumps and motors.

Three laboratory hours per week. Junior year.

To be taken concurrently with S. E. 1.

Economics

3 E. ECONOMICS

Professor Crafer.

Winter Term, 3 credits.

A brief resume of economic theory. Discussion of practical economic problems; wages, interest, rent, currency, banking, taxation, trusts, tariff, socialism.

Text-books and lectures. Junior year.

10, 11. TRANSPORTATION

Professor Flocken.

Fall and Winter Terms, 2 credits each term.

The origin and growth of the American railways. Their present ownership and control. The organization of the railway company, and how it does its work. Railway financing. The freight, passenger, express and mail service. Railway abuses. Regulation by the states and by the Federal Government. The Interstate Commerce Commission. Government ownership in the light of foreign experience. Railway rates and fares. Electric railway transportation. Ocean transportation. Ocean highways and seaboard terminals. The organization of ocean freight, passenger, express and mail service. The merchant marine. The question of subsidies. The river, lake and canal systems of the United States. The increasing importance of the inland waterways question. Text-book, lectures and assigned readings. Text-book, Johnson's Elements of Transportation.

13. MODERN INDUSTRIES

Professor Flocken.

Fall Term, 2 credits.

A study of the leading American industries, physiographic control, source and supply of raw material, agricultural resources. Factors affecting the location of industry. Sources and application of power. Manufacturing methods, and factors affecting cost of production. Large scale versus small scale production. Internal commerce and foreign trade. Lectures, assigned readings and reports.

16. INDUSTRIAL MANAGEMENT

Professor Flocken.

Winter Term, 2 credits.

Advantages of various methods of business organization and management. The internal management of the large business or plant and the differentiation of the duties of various departments. Profit-sharing schemes. Labor problems. Markets and methods of distribution. A study of actual industrial conditions by visits to the mills and shops of Pittsburgh, special attention being given to the handling of raw material, the arrangements of plant, and shipping facilities. Lectures, assigned readings, reports, field work.

1. LABOR PROBLEMS

Professor Flocken and Mr. —

Winter Term, 3 credits.

The characteristic features of American industry and immigration with reference to the supply of labor. The organization, machinery, and methods of the trade-union and the employers' association. The planning and conduct of strikes and boycotts. The open and the closed shop. Arbitration and conciliation. Industrial efficiency. Labor legislation. The Federal and State Laws and decisions relating to labor, the factory and sweatshop, and employer's liability. Text-book and assigned readings. Text-book, Adams and Summer's Labor Problems.

21. CORPORATION FINANCE

Professor Holdsworth.

Fall Term, 3 credits.

Types of business corporations. The genesis of the trust. The financial organization and management of corporations. The promoter and the underwriting syndicate. The disposition of gross earnings and the provision of new capital. Charter, articles and by-laws. Stockholders' powers, rights and liabilities. Dissolution, receiverships and reorganizations. Lectures and text-book, assigned readings and reports. Text-books, Lough's Corporation Finance.

24. INVESTMENTS

Professor Holdsworth.

Winter Term, 3 credits.

The general characteristics and merits of government and municipal bonds, and of railway, industrial, public service corporation, power irrigation securities. The farm and city mortgage. How securities are purchased and marketed. The organization of the investment business. A study of fluctuations in bond and stock prices to determine the influence acting upon security values. Analysis of typical securities and railroad reports. Examination of savings banks and trust company holdings. Lectures, assigned readings and reports.

27. BROKERAGE

Professor Holdsworth.

Spring Term, 3 credits.

The organization and machinery of stock and produce exchanges. The terminology of the stock market. How stocks and bonds are listed and dealt in. Speculation. Dealing in "futures." Bucket shops. The "curb."

Investment brokerage. The relation of the stock exchange to the country and to the banks. The broker and his work. The legal relationship of broker and customer. Lectures and reports.

46. CONTRACTS AND SPECIFICATIONS

Professor Crafer.

Spring Term, 3 credits.

In this course are presented the essential elements of a contract, the law pertaining thereto and parties who may contract. The consideration, discharge and remedies for breach of contract. Forms of proposals, specifications and illustrative examples of complete contracts and specification for various engineering projects are given.

Sociology

1, 2, 3. THEORY OF SOCIOLOGY

Professor Crafer.

Fall, Winter and Spring Terms, 2 credits each.

This course includes a study of the development of sociology, its importance and place in the social sciences, and of the underlying biological, physical and psychical factors in sociology.

Psychology

20. PSYCHOLOGY FOR STUDENTS IN THE SCHOOL OF MINES

Professor White. Fall Term, 5 credits; Spring Term, 1 to 3 credits.

A course designated to give

(a) The general principles of psychology;

(b) A general survey of the whole field of psychology;

(c) Special applications to the problems of individual differences of character; race psychology; suggestion and choice, custom, conventionality, imitation, cooperation, competition; psychology of the gang, the crowd, the mob; psychology of responsibility; ownership, etc., etc.; psychology applied to everyday life.

This course is arranged for students taking the course in Management. Five lectures per week will be given in the fall term.

During the spring term the work will consist of conferences, at which will be discussed problems which have arisen during the field work of the winter term. This will be of great value to all who expect to become executives.

Mineralogy and Petrography

Professor Leighton.

1. GENERAL MINERALOGY.

Fall Term, 2 credits.

Designed primarily for civil engineering students but open to anyone desiring a brief course in the subject. About 75 minerals and a few common rocks are studied.

2, 3, 4. GENERAL MINERALOGY.

Fall, Winter and Spring Terms, 3 credits each term.

Includes the subjects of crystallography, mineralogy and lithology. Required of all students in the School of Mines and open to any qualified student who desires a comprehensive knowledge of the subject. About 250 mineral species are studied and stress laid on the actual determination of unlabelled material.

5. MATHEMATICAL CRYSTALLOGRAPHY.

Winter Term, 2 credits.

The calculation of axial ratios and other constants in crystals and the methods of projecting and drawing crystals.

Pre-requisites: Math. 4; Min. 2, 3, 4.

6. ADVANCED MINERALOGY.

Advanced or research work in crystallography, mineralogy or lithology. Primarily for graduate students, but open to all having sufficient training. Credits and courses to suit the needs of the student.

Pre-requisites: Chem. 3, 4, 8; Min. 2, 3, 4.

7, 8, 9. PETROGRAPHY.

Includes a study of optical crystallography, the optical determination of minerals, and the determination and classification of rocks by microscopic methods.

Pre-requisite: Min. 2, 3, 4.

10. ADVANCED PETROGRAPHY.

Credits vary.

Designed to meet the needs of individual students.

Geology

Professor Johnson

1. GENERAL GEOLOGY.

Fall Term, 3 credits.

Instruction is given by means of text-book and lectures on the general principles of geological science, including the probable origin and structure of the earth; volcanic and earthquake action; the destructive and reconstructive action of air and water, both surface and subterranean; the important earth-building minerals and rocks, their alterations and accidents; geological topography, etc. Text-book, Scott's Introduction to Geology.

Required of all Sophomores.

2. HISTORICAL GEOLOGY.

Winter Term, 3 credits.

The history of the earth from the beginning of the solar system. A comparison of the state and life of the several periods. The changes of the continental outlines, climates and mountains. Three credits.

Required of all Sophomores.

3. STRUCTURAL AND FIELD GEOLOGY.

Spring Term, 5 credits.

A course in the method of determining the geological structure and condition of land areas and in interpreting the facts observed.

Required of all Sophomores.

Paleontology

Professor Eastman

1, 2, 3. GENERAL PALEONTOLOGY.

Fall, Winter and Spring Terms, 4 credits each term.

Intended to present a general survey of the field of Invertebrate Paleontology.

Required in Group III.

Economic Geology

Professors Leighton and Johnson.

1, 2, 3. ECONOMIC GEOLOGY.

Fall, Winter and Spring Terms, 3 credits each term.

The mode of occurrence, origin, distribution and uses of the non-metallic and metallic mineral resources are discussed, special attention being given to the deposits of the United States.

Pre-requisites: Min. 2, 3, 4; Geol. 1, 2, 3.

Required in Groups I and III.

4, 5, 6. GEOLOGY OF THE IRON ORES.

Fall, Winter and Spring Terms, 2 credits each term.

Given in alternative years with Ec. Geol. 7, 8, 9. Given in 1913-1914.

7, 8, 9. GEOLOGY OF COAL.

Fall, Winter and Spring Terms, 2 credits each term.
Given in alternate years with Ec. Geol. 4, 5, 6. Given in 1912-1913.
Must be preceded by or taken with Ec. Geol. 1, 2, 3.

10, 11, 12. ADVANCED ECONOMIC GEOLOGY.

Credits vary.

This course is intended primarily for graduate students and can be planned to suit the individual.

Pre-requisite: Ec. Geol. 1, 2, 3.

13, 14, 15. SEMINAR.

Fall, Winter and Spring Terms, 1 credit each term.

The current periodicals and new publications are reviewed.

Must be preceded by or taken with Ec. Geol. 1, 2, 3.

Required in Group III.

16, 17, 18. GEOLOGY OF OIL AND GAS.

Fall, Winter and Spring Terms, 2 credits each term.

Must be preceded by or taken with Ec. Geol. 1, 2, 3.

Required in Group I-c.

19, 20, 21. OIL AND GAS LABORATORY.

Credits vary.

To accompany Ec. Geol. 16, 17, 18.

Experimentation in the role of gravitational sorting, capillarity and hydraulics in the accumulation of oil. Experience in using the geologic reports, maps and records of oil fields. Group I-c.

22, 23, 24. SEMINAR IN OIL AND GAS.

Fall, Winter and Spring Terms, 1 credit each term.

A weekly meeting to watch current oil and gas development and to consider the current literature. Required in Group I-c. See also Geology 1-6 in the College, and Geology 7-9 in the Graduate School.

Mining

Professors Meller, Black and Johnson, Dr. Wallgren, Mr. Zimmerman.

The aim of the curriculum in Mining Engineering is to impart such knowledge as will enable the student to successfully carry through a mining enterprise. In order to intelligently conduct mining operations, he will be called upon as an engineer to employ the principles of mathematics, physics, and mechanics; the sciences of geology, mineralogy, chemistry and metallurgy; and the arts of civil, mechanical, and electrical engineering; he must also have capacity for organization and business management.

The principles, sciences, and arts mentioned are taught by specialists in the different departments, their particular application to Mining being specially emphasized.

Three lines of election are offered to the student:

The Mining of Coal.

The Mining of Metals and Stone.

The Mining of Petroleum and other Hydrocarbons.

Besides the courses under the heads mentioned, there are courses relating to business methods and the economics of mining, which deal with the problems confronting the mine manager, operator, and financial agent. A knowledge of these subjects has usually been gained by experience alone in the active mining-field; but a number of carefully selected courses of this character are included in the curriculum of the School.

In connection with the department is a laboratory, equipped with the most modern machinery used in underground work, steam, air, and electricity being directly available as power.

Class instruction is supplemented, where possible, by visits to mines in the vicinity; by reference to mine maps, models, drawings, and descriptions of plants, etc.

1, 2. PRINCIPLES OF MINING

Fall and Winter Terms, 3 credits each term.

This course is intended to give a resume of the principles of mining and is required of all students in the School. It is also to serve as a basis for subsequent study in the department. The course includes instruction in:

1. Modes of occurrence of minerals; as beds or seams, veins, and masses.

2. Prospecting; aids, methods, outfits, etc.

3. Boring; purposes and methods of.

4. Breaking ground; by hand tools, by machinery; blasting.

5. Support: rock pillars, timber, masonry, brickwork, metallic supports.

6. Exploitation: open, subaqueous, and underground workings, etc.

7. Haulage: methods not involving the use of rails; railways; aerial ropeways.

8. Hoisting: motors, drums, pulley frames; ropes and rope attachments; receptacles, as buckets, cages, skips, safety appliances, etc.

9. Drainage: surface and mine.

10. Ventilation: pure air, constitution and requirements; mine air pollution; natural and artificial ventilation; testing mine air; accidents from mine gases, and their prevention; rescue and resuscitation; etc.

11. Lighting: candles, torches, lamps.

Visits of inspection are made to mines in the vicinity in order that the students may become familiar with the practical application of the principles discussed in the class-room.

3. ORE MINING METHODS

Spring Term, 3 credits.

Methods of support in extraction of ore; methods of stoping and mining in narrow and wide veins and bedded and massive deposits, including stull and square-set mining, filling and caving methods, and open-cut work.

Required in Group I-a.

4. COAL MINING METHODS

Spring Term, 3 credits.

A study of mining methods used in the various seams in the anthracite regions of Pennsylvania; the methods as found in the Pittsburgh, Connellsville, Fairmont, New River and other districts; also a study of the longwall system as found in Illinois.

Required in Group I-b.

5. MINE GASES AND EXPLOSIONS

Spring Term, 3 credits.

Treats of the composition and physical properties of gases commonly found in mines. Effect of dust and atmospheric conditions in explosions. Mine rescue work, underground hospitals, etc., etc. Concludes with a study of mine lamps and gas indicators.

Required in Group I-b.

6. MINE GAS ANALYSIS

Fall Term, 3 credits

The analysis of mine air to determine percentage of CH_4 , CO_2 and CO in return air-current.

Required in Group I-b.

7. VENTILATION

Winter Term, 4 credits.

A study of the laws governing the passage of air-currents in a mine,

and involving the use of formulae with which a study of ventilation is so closely associated.

Required in Group I-b.

8. COMPRESSED AIR IN MINING

Fall Term, 2 credits.

A study of air compression, expansion, flow of air through pipes, the various types of air compressors and of machines using compressed air as power.

Elective. Advised in Group I.

9. POWER TRANSMISSION IN MINES

Winter Term, 2 credits.

A lecture course bearing on the installation of boilers, engines, generators, air compressors, etc., at mines, and the transmission of power to all sections of the mine interior.

Required in Group I-a and b.

10. PLACER MINING

Fall Term, 2 credits.

Occurrence of auriferous gravel deposits, methods of prospecting, development and working. Ground sluicing, river mining, drift mining, hydraulicking and dredging.

Required in Group III. Advised in Group I-a.

11. UNDERGROUND SURVEYING

Winter Term, 3 credits.

In this course are taught: The theory of underground practice in surveying; carrying the meridian underground by various methods, such as 2-wire, 3-wire, 4-wire, and with auxiliary telescope; survey of secondary openings, recording of survey, use of mine maps, etc. The three hours practical work per week are utilized by the student in acquiring familiarity with setting up under instead of over a point, and in sighting in the dark, use of the tape, plotting of notes, etc. Several days' underground surveying are included in the Field Trip (see page—).

Required in Groups I-a, I-b, III.

12, 13. MINE PLANT DESIGN

Winter and Spring Terms, 3 credits each term.

Design of surface structures, such as head-frame, ore-bins, tippie, boiler house, etc.

Required in Group I-a and b.

14. PROJECTION OF MINE WORKINGS

Spring Term, 3 credits.

Under this heading the student is taught the projection of mine workings, the order in which rooms are to be worked and ribs to be drawn, and the writing of specifications governing methods of working, ventilation, etc.

Required in Group I-b.

15. FIRST AID AND MINE RESCUE WORK

Spring Term, 2 credits.

This course includes instruction in the following subjects: Bruises, Sprains, Fractures, Shock, Burns and Gas Poisoning, etc.; Principles, Design and use of the Helmet and Mouth-Breathing Devices, Resuscitation Apparatus, and in the Methods of Mine Rescue Work.

Required in Group I. Advised in Group II.

16, 17. COKE MANUFACTURE

Winter and Spring Terms, 3 credits each term.

A study of the physical properties and methods of manufacture of coke. The various types of ovens in use in this country and abroad are studied. Special attention is given to by-product ovens.

Required in Group I-b.

18, 19. MINING COSTS AND MINE MANAGEMENT

Fall and Winter Terms, 3 credits each term.

This course covers: Considerations which should precede the opening of mines, as topography, labor conditions, climate, transportation facili-

ties, etc.; incorporation and capitalization; promotion of mining and exploration companies; investments in mines and mining stocks; reasons for failures in mining; mine administration; details of costs for operation, maintenance, depreciation and amortization; etc. Following this is a study of mining costs of representative companies in the various mining fields of the world.

Required in Group I.

20. MINE VALUATION

Spring Term, 2 credits.

A study of the factors which assist the engineer in determining the value of a producing mine or a prospect; conduct of the examination; report, etc.

Required in Groups I and III.

21, 22. MINING LAW

Winter and Spring Terms, 2 credits each term.

The principles of law and introduction to mining law; followed by general mining law.

Required in Groups I and III.

23, 24, 25. SEMINAR

Fall, Winter and Spring Terms, 1 credit each term.

This course is given to familiarize the student with current technical literature.

Required in Group I. At intervals the Seniors in all groups meet together for discussion.

26. INSPECTION TRIPS

Winter Term, 1 credit.

During the Winter term of the Junior year, Saturdays are set aside for visits of inspection to working coal mines in the vicinity. Before each visit the class is assembled and told what particular features to observe on that week's trip, and written reports are required in every case.

27, 28. THE PRODUCTION OF OIL AND GAS

Fall and Winter Terms, 4 credits each term.

The production of oil and gas from the time the area has been chosen for prospecting. Leasing, disposition of wells, drilling, torpedoeing, pumping, storage, transportation, sale.

The appraisal of oil and gas properties; management. General outline of the oil and gas industry.

Pre-requisite: Ec. Geol. 10, 11, 12.

Required in Group I-c.

29. THE EXAMINATION OF AN OIL OR GAS PROPERTY

Spring Term, 5 credits.

The actual examination, and preparation of a report, with maps, of some accessible oil or gas property.

Required in Group I-c.

30, 31, 32. MINING ENGINEERING

Fall, Winter and Spring Terms, 3 credits each term.

This course is supplementary to Mine 1, 2, 3 and 4, which are mainly descriptive. A number of problems are introduced, and a considerable amount of original work on the part of the students is involved.

Required in Group I-a and b.

33. PETROLEUM REFINING.

Spring Term, 3 credits.

Required in Group I-c.

34, 35, 36. MINING LABORATORY

Credits vary.

Metallurgy

Professors Goodale, Ray, Benner and Brownlee.

Metallurgy is the art of extracting metals from their ores or other sources and preparing the metal for practical use. It is often considered to be a branch of applied chemistry; it is so, but draws as well upon the various divisions of physics. To take up the study of metallurgy, a student should, therefore, be well prepared in the sciences of chemistry and physics.

The subjects considered in metallurgy are of a practical kind, and the cost of operations must generally be kept in view in order to conduct them profitably. The general subject may be subdivided in a number of ways, as for instance: 1. Mechanical treatment of ores. 2. Chemical treatment. 3. Furnace operations. 4. The finished product.

Under the head of mechanical treatment comes the preparation of the raw product of the mines by mechanical processes only for more expensive treatment to follow. This includes ore-dressing and coal-washing, and takes up in detail the study of crushing ores, concentrating by jigs or tables depending on the difference in specific gravity between minerals, or by magnetic or static separators, or concentration by oil processes, etc.

The chemical processes include the study of cyanidation, by which most of the gold is recovered. There are also many other chemical processes, such as those for recovering copper from low grade ores, silver by hypsulphite leaching, etc. This may also be considered to include many of the extremely important electro-chemical methods such as the refining of copper, gold and silver, by which processes metals of the highest purity are obtained commercially.

The study of furnace operations, however, is still the great study of the metallurgist. These include such great furnaces as the iron blast furnace, the open hearth and Bessemer furnaces for refining iron and producing steel, and all the furnaces used in the iron and steel industry. In the metallurgy of each metal certain furnaces are used—in copper smelting, both blast and reverberatory furnaces, sometimes of very great size, in zinc smelting, retort furnaces, and so on. The roasting of ores to remove impurities is studied under this head.

The finished product. It is the business of the metallurgist to secure the metal from its ore, and to get the metal into a condition fit for commercial use. Therefore the study of the properties of metals and alloys is of utmost importance to the metallurgist. The usefulness of a metal commercially hinges often upon the presence or absence of other elements to the extent of one-fifth of one per cent. or less, as for instance phosphorus in rail-steel can not be allowed to exceed that limit because of brittleness if more is present, and numerous other similar instances could be cited.

Therefore the metallurgist studies the operations of the iron and steel industry, the copper smelter, the gold and silver mill, the ore-dressing plant, etc. It is seen to be a very broad field, and any one man can become an expert in only a small section of it, in addition to having a good general knowledge of the whole field.

It is the aim of the school training to teach the underlying principles mainly, and give the student a good general knowledge of the field of metallurgy, together with as much more extended study of one branch as the time allotted will permit. The courses in Metallurgy are designed to prepare the student for work in the iron and steel plants, copper and lead smelters, gold mills, etc., both in the technical and managerial departments.

1a, 2a, 3a. GENERAL METALLURGY

Fall, Winter and Spring Terms, 3 credits each term.

A general introductory course covering the metallurgical preparation

and properties of the common metals. Text-book for fall and winter, Austin's Metallurgy of the Common Metals; for spring, Stoughton's Metallurgy of Iron and Steel.

Required of all students in School of Mines.

1b, 2b, 3b. GENERAL METALLURGY—LABORATORY

Fall, Winter and Spring Terms, 2 credits each term.

A laboratory course dealing with the methods of and apparatus for measurement of heat, thermal power of fuels, etc. Also a laboratory study of chemical and physical principles underlying metallurgy of common metals.

Required by all students in Group II. In Groups I, III, Fall Term, 1 credit; Winter and Spring, 2 credits. Group IV requires 1 credit all three terms.

4, 5, 6. ORE DRESSING AND STAMP MILLING

Fall, Winter and Spring Terms, 3 credits each term.

This course is designed to give the student the principles and practice of breaking and concentration of ores. Two terms are devoted to crushing, grinding, sizing, jigging and other methods of concentration, the underlying principles being studied in detail; and the third term to stamp milling and amalgamation. Text-book, Richard's Ore Dressing. Two terms are required of all students in the School of Mines, three for Group II-a, and three for Group I-a.

7, 8, 9. GENERAL METALLURGICAL PRINCIPLES

Fall Term, one lecture, 6 hours laboratory work; winter and spring terms, 3 recitations. 3 credits each term.

This course comprises a study of metals, alloys, metallurgical materials and products, fuels, furnaces, measurements, etc. Text-book, Fulton's Principles of Metallurgy. Required in Group II.

10, 11, 12. METALLURGICAL CALCULATIONS.

Fall, Winter and Spring Terms, 3 credits each term.

A study of the calculations relating to quantities of heat and material, and cost involved in furnace and other operations of metallurgy. Text book, Richard's Metallurgical Calculations. Elective, advised for all candidates for metallurgical degree. 10 is required for either 11 or 12, but 12 does not necessarily require 11.

13, 14, 15. IRON AND STEEL

Fall, Winter and Spring Terms, 6 credits one term, 4 credits two terms

This course comprises a detail study of the blast furnaces, the open hearth and other steel furnaces, and the principles and practice of the manufacture of iron and steel. Text books, Forsythe's Metallurgy of Iron, Harbord and Hall Metallurgy of Steel. Required in Group II-b.

16, 17, 18. COPPER, LEAD, THE MINOR METALS

Fall, Winter and Spring Terms, 4 credits each term.

This course is intended to give a thorough knowledge of the metallurgy of copper, lead, and other common metals. Text books, Peter's Practice of Copper Smelting; Hofman's Metallurgy of Lead; Schnabel's Handbook of Metallurgy. Required in Group II-a.

19, 20, 21. ELECTRO-METALLURGY

Fall, Winter and Spring Terms, 5 credits each term.

A careful study of the electrothermic and electrolytic processes applied to the recovery and refining of metals. Text book, Thompson's Applied Electro-Chemistry. Three recitations and 6 hours laboratory work per week. Elective. The course is advanced work and requires a knowledge of chemistry, elementary electricity and metallurgy. This course takes up some of the most interesting and promising phases of metallurgy.

This course covers the metallurgy of gold and silver with special reference to the hydro or leaching processes such as cyanidation, the most important, chlorination, etc. The cyanide process is treated in detail on account of its present and growing importance. The refining of bullion by different methods is also thoroughly gone into. Elective, advised for candidates for metallurgical degree, Group II-a.

23. COAL WASHING 1 Term, 3 credits.

The study of the preparation of anthracite and bituminous coal for the market or for special use. It includes crushing, picking, screening, jigging and other methods of washing. Required in Group I-b.

Pre-requisite: Met. 4 and 5.

24, 25. FIRE ASSAYING Fall Term, 3 credits; Winter Term, 2 credits.

This course is designed to give the student a thorough theoretical and practical knowledge of the assaying of ores of gold, silver, and platinum by fire methods. Commercial laboratory methods giving speed of manipulation are taught, as well as more refined methods for special accuracy. Elective. Required in general metallurgy option, Group II. One term required in Group I, and in Group II-b.

26. MANGANESE, NICKEL, COBALT, VANADIUM, CHROMIUM, TUNGSTEN, ETC.

Any Term, 3 credits.

A study of the manufacture, properties and uses of those metals that are of special interest in alloy steels. Elective.

Pre-requisite: general knowledge of metallurgy.

27, 28, 29. METALLURGICAL DESIGN

Fall, Winter and Spring Terms, 2 to 4 credits each term.

Draughting room work in preparing plans for metallurgical machinery, plants, processes, etc. Elective.

Pre-requisite: detailed study of the courses given referring to the problem undertaken.

30, 31. METALLOGRAPHY

2 Terms, 3 credits each.

A study of metals and alloys, their structure, properties, etc. Laboratory work with the microscope, photo-micrography, testing, etc.

Junior or Senior year. Advised for Group II.

32. INSPECTION TRIPS

Any Term, 1 credit.

Visits to metallurgical plants, equivalent of one afternoon a week for 10 weeks with reports and reading on each trip required. Elective, open to all students of the University.

33, 34, 35. GENERAL LABORATORY WORK, ADVANCED

Any Term, 2 to 18 credits.

Opportunity is given to the student to take up some problem of interest for detailed study and laboratory experimentation. Elective, open to advanced students.

36, 37, 38. REFERENCE WORK IN CURRENT LITERATURE

Fall, Winter and Spring Terms, 1 credit each term.

This course is to give the student familiarity with the technical press, and is required in Group II. Seniors in all groups meet together at intervals for discussions.

39, 40, 41. SPECIAL WORK

Any Term, 2 to 18 credits.

It is desired to give students an opportunity to specialize, as far as the facilities of the School permit, along any line in metallurgy. The work is carried along in each case as the occasion seems to require, in order to give each student the greatest advantage from his work. Elective.

Ceramics

Professor Leighton

The instruction in ceramics is planned so as to give each student a

broad engineering training and to furnish him with the fundamental ideas regarding the properties of clays and their methods of manufacture. The course is arranged in such a way that by the proper use of the electives a man may undertake work along various lines, such as pottery and porcelain manufacture, the manufacture of refractories, brick manufacture, etc., although the main object in view will be to turn out men who will be fitted to enter any line of clay mining, clay manufacture, clay investigation or ceramic teaching and prove competent.

1, 2, 3. EXAMINATION AND TESTING OF CLAYS.

Fall, Winter and Spring Terms, 3 credits each term.

Includes a study of the origin and properties of clay and a study of the various physical and chemical tests generally applied in investigations.

Pre-requisites: Chem. 3, 5, 8; Physics 11, 12, 13.

4, 5, 6. TECHNOLOGY OF CLAYS.

Fall, Winter and Spring Terms, 2 credits each term.

The manufacture of clay products.

7, 8, 9. INSPECTION TRIPS.

Fall, Winter and Spring Terms, 1 credit each term.

Trips are made to nearby manufacturing plants.

Taken with Cer. 4, 5, 6.

10, 11, 12. POTTERY AND PORCELAIN

Fall, Winter and Spring Terms, 2 credits each term.

A study of ceramic calculations, glazes, pottery bodies, etc.

Pre-requisite: Chem. 12, 13, 14.

13, 14, 15. CERAMIC LABORATORY.

Fall, Winter and Spring Terms, 5 credits each term.

Special work on the formation, burning and testing of clays and clay products.

Pre-requisite: Cer. 1, 2, 3.

16. ADVANCED CERAMICS.

Credits vary.

Work in this course can be arranged to meet the desires or need of the student. Primarily for graduate students.

17, 18, 19. SEMINAR.

Fall, Winter and Spring Terms, 1 credit each term.

By review of current literature and a study of the important papers previously issued, the student is made familiar with ceramic writings and the progress of the sciences.

Pre-requisite: 1, 2, 3.

20, 21. PLANT DESIGN. Fall and Winter Terms, 3 credits each term.

Field Trip

6 credits.

The work of the Junior year is so arranged that the winter term ends one week earlier than in the other Schools of the University, and the spring term begins one week later. This leaves three weeks intervening for a field trip, which will be required of all students in the School, except those who, in the opinion of the Faculty, shall have had a sufficient amount and variety of practical experience to warrant their being excused. No fee is charged for this course. The necessary expenses for each student for the three weeks are estimated at \$75.00.

Three separate trips have been arranged, to alternate.

(1) Eastern Pennsylvania and New York.

(2) Michigan iron and copper country.

(3) Southern coal, iron and copper fields.

The localities visited afford opportunity for advanced work in mining, metallurgy and geology. Special work is assigned to each student, and he is required to keep a careful record of his observations and investigations. At the end of the trip, a complete report, with sketches, is required. All work is done under the supervision of instructors from the School.

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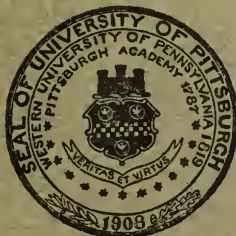


University of Pittsburgh Bulletin

ANNOUNCEMENT SERIES

THE SCHOOL OF MINES

1914-1915



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SCHOOL OF MINES CALENDAR

1914

September 21-26.....Monday to Saturday Registration.

September 25..... Friday, 10:30 A. M. Opening Exercises, Fall Term,
Memorial Hall.

September 28.....Monday, Recitations begin.

November 26-28.....Thanksgiving recess, Thursday to Saturday.

December 19.....Saturday—Fall Term ends.

Term Vacation from Monday, December 21 to Monday, January 4.

1915

January 4.....Monday—Winter Term begins.

February 28.....Sunday—Charter Day.

March 20.....Saturday—Winter Term ends.

March 22.....Monday—Spring Vacation of one week begins.

March 29.....Monday—Spring Term begins.

April 2..... Good Friday, holiday.

June 13.....Sunday—Baccalaureate Sermon.

June 16.....Wednesday—Commencement.

June 21.....Monday—Summer Term begins.

August 28.....Saturday—Summer Term ends.

OFFICES AND OFFICE HOURS

Office, State Hall, Grant Boulevard—Consultation Hours: 8:30 A. M.
to 5:30 P. M.

General Office, State Hall; Telephone Schenley 3300.

For catalogs and other information, address the Secretary of the University, Grant Boulevard.

FACULTY

SAMUEL BLACK McCORMICK, A.M., D.D., LL.D., CHANCELLOR.

S. B. LINHART, A.M., D.D., SECRETARY OF THE UNIVERSITY.

ALBERT ELLIS FROST, A.M., Sc.D., REGISTRAR.

MARSHMAN EDWARD WADSWORTH, A.M., PH.D., DEAN and Professor of Mining Geology EMERITUS; Curator of Geological and Mineralogical Collections.

SAMUEL ALFRED TAYLOR, C.E., DEAN.

HARRY BERTINE MELLER, E. M., VICE-DEAN; Professor of Mining.

STEPHEN LINCOLN GOODALE, A.M., E.M., Professor of Metallurgy.

HORATIO CADWALLADER RAY, B.S., E.M., Assistant Professor of Metallurgy.

HENRY LEIGHTON, A.B., Assistant Professor of Economic Geology.

ROBERT MOFFITT BLACK, A.B., B.S., E.M., Assistant Professor of Mining.

ROSWELL HILL JOHNSON, M.S., Assistant Professor of Geology, and of Oil and Gas Mining.

ALEXANDER SILVERMAN, PH.B., A.B., M.S., Professor of Analytical Chemistry; Lecturer upon Glass Manufacture. In charge of Glass Research.

ANDREW BENNETT WALLGREN, M.D., Lecturer on First Aid to the Injured.

JAMES ZACHARIAH ZIMMERMAN, B.S., Instructor in Mining.

VICTOR C. SVIMONOFF, B.S., Instructor in Surveying.

PAUL LELAND SIMPSON, E.M., Fellow in Metallurgy.

INSTRUCTORS IN OTHER DEPARTMENTS GIVING INSTRUCTION IN SCHOOL OF MINES.

FRANCIS CLIFFORD PHILLIPS A.M., PH.D., Professor of Chemistry.
JOHN HAMMOND SMITH, E.E., Professor of Civil Engineering.
JESSE HAYES WHITE, A.M., PH.D., Professor of Psychology.
FREDERIC LENDALL BISHOP, PH.D., Professor of Physics.
JOHN THOM HOLDSWORTH, PH.D., Professor of Finance and Economics.
ARNOLD EDWARD ORTMANN, PH.D., Professor of Paleontology.
BENJAMIN TALBOT BROOKS, PH.D., Professor of Petroleum Refining.
FRANCIS JEROME HOLDER, A.M., PH.D., Professor of Mathematics.
CALVIN NAFTZINGER WENRICH, A.M., PH.D., Professor of Physics.
LESLIE HUNTINGTON HARRIS, B.S., Associate Professor of Electrical Engineering.
EMMET FRANCIS HITCH, A.M., PH.D., Assistant Professor of Organic and Technical Chemistry.
IRA GRAESSLE FLOCKEN, A.M., Assistant Professor of Industry and Accounting.
ALEXANDER VON RITTER, M.E., Assistant Professor of Heat Engineering.
GEORGE W. CASE, C.E., Assistant Professor of Sanitary Engineering.
CHARLES O. BROWN, A.M., Assistant Professor of Electro-Metallurgy.
EDWARD HOWARD DYCHE, M.E., Instructor in Electrical Engineering.
JOHN WEBER, M.E., Assistant Professor of Mechanical Engineering.
EDWARD HOWARD DYCHE, M.E., Instructor in Electrical Engineering.
ISAAC BOYCE, D.D., Instructor in Spanish.
LOUIS FRANKLIN SNOW, PH.D., Instructor in English.
DAYTON ULREY, A.B., Instructor in Physics.
CHARLES BOYLE CAMPBELL, PH.D., Instructor in German.
FOREST A. FORAKER, M.S., Instructor in Mathematics.
LESTER CHIPMAN McCANDLISS, B.S., Instructor in Civil Engineering.
MARKS NEIDLE, A.M., PH.D., Instructor in Analytical and Physical Chemistry.
FRANK D. TYSON, PH.D., Instructor in Sociology.
WHITFORD HUSTON SHELTON, A.M., PH.D., Instructor in Romance Languages.
GEORGE HARRY SWERGER, Assistant in Elementary Mechanical Engineering.
CHARLES SHIVELY MILLER, Director of Physical Education.
HARRY HOLTON PROVIN, Instructor in Physical Education.

LOCATION

STATE HALL, the SCHOOL OF MINES BUILDING, is located at the corner of Grant Boulevard, Bayard Street and Parkman Avenue, opposite the Soldiers' Memorial, and near the Carnegie Institute, including Museum and Library. It is readily accessible from all parts of the city.

SPECIAL ADVANTAGES

The location of Pittsburgh, in the very heart of the bituminous coal fields of the Appalachian system, and in the most richly productive oil fields of Western Pennsylvania, with the great concentration here of mining, metallurgical and ceramic interests, makes this undoubtedly one of the most advantageous points in the United States in which to study mining, metallurgy and ceramics.

It is also conveniently located with reference to the bituminous coal fields of Ohio and West Virginia, the anthracite fields of Eastern Pennsylvania, and the Lake Superior iron and copper region.

REQUIREMENTS FOR ADMISSION

All candidates for admission to the School of Mines must be at least seventeen years of age and furnish testimonials of good moral character. Those who come from other institutions must present certificates of honorable dismissal.

METHODS OF ADMISSION

I. CERTIFICATES of the College Entrance Examination Board and of the New York Regents are accepted in lieu of entrance examinations at the University.

For information concerning the dates upon which the examinations of the College Entrance Examination Board are to be held, address The Registrar of the University of Pittsburgh.

II. CERTIFICATES FROM ACCREDITED SCHOOLS. Instead of examination, certificates from high schools and academies whose work has been approved by the University as being equivalent to that required for admission to the Freshman class, will be accepted. The official blank provided by the University should be used. It may be obtained upon application to the Registrar or Dean.

III. FROM OTHER COLLEGES. Students from other institutions whose entrance requirements are equivalent to those of the University of Pitts-

burgh and which offer equivalent courses of study, will be given provisional credit for the work done and admitted to advanced standing without examination. If their work proves satisfactory, the provisional credits will be made permanent.

IV. SPECIAL STUDENTS. Students showing satisfactory evidence of ability, but who are not candidates for a degree, may be admitted without examination to take such work as they are prepared for. This includes students taking irregular or partial courses owing to lack of time to follow the regular course as well as persons of age and experience in practical work who wish to take special courses.

SUBJECTS OF EXAMINATION

For admission to the School of Mines the student who is a candidate for a degree must offer fifteen units, a unit being the equivalent of four recitations per week of one hour each for one year, or five recitations of three-quarters of an hour each.

The units are as follows for 1914:

English, 3 units.

Mathematics, Algebra, $1\frac{1}{2}$ units.

Mathematics, Plane and Solid Geometry, $1\frac{1}{2}$ units.

History, 1 unit.

German or French, 2 units. (Spanish may be substituted).

Physics, 1 unit.

Five additional units must be offered from the approved list (see Bulletin of General Information).

CONDITIONS

No applicant with more than three entrance conditions will be admitted as a regular student. Conditions must be at least partly removed before the second year, and wholly before the third.

SCHOLARSHIPS

A limited number of scholarships are available in the School of Mines. These scholarships entitle the holders to free tuition. For information concerning the conditions under which they are awarded apply to the Secretary of the University or the Dean of the School of Mines.

TUITION AND FEES

The tuition covers all fees except those specially mentioned below, and must be paid, with all current fees, upon registration, before name can be entered on class rolls.

Matriculation Fee (at entrance only)	\$ 5.00
Tuition, Fall Term	40.00
Tuition, Other Terms	35.00
Tuition per year, if paid in advance (except Freshman Year)).....	105.00
Tuition Freshman year (four terms), if paid in advance.....	140.00
Chemistry, Physics, Engineering, each course.....Per Term	5.00
Assaying, (Fire)	Per Term 10.00
Metallurgical Laboratory... {	Fall Term 5.00
.....Winter and Spring Terms, each	10.00
Electro-Metallurgy	Per Term 5.00
Mineralogical Laboratory, Metallography, each.....Per Term	3.00
Surveying (Summer Course)	10.00
Special Laboratory Work	Fees by arrangement
Breakage Deposit for all students taking laboratory work.....	10.00
(Any balance remaining will be returned.)	
Diploma	5.00
Student Activities, per year	3.50

DEGREES.

The degrees conferred upon those satisfactorily completing courses offered are, respectively:

Engineer of Mines (E. M.), Metallurgical Engineer (Met. E.), Geological Engineer (Geol. E.), Ceramic Engineer (Cer. E.).

THESIS.

A thesis is required of every candidate for degree. The thesis subject, together with an outline of the work proposed, must be approved by the head of the department in which the student is classified, not later than January 15th preceding commencement; and when so approved will be assigned him on a blank furnished for the purpose. A memorandum of this assignment must be filed in the office of the Dean.

The thesis in the proposed final form must be submitted to the Professor in charge at least two weeks prior to commencement, and must be in the hands of the Dean before Commencement Day.

The results obtained and the thesis prepared in connection with a regularly assigned thesis subject are the property of the University and no part of the thesis may be published without the consent of the Chancellor.

COURSES IN THE SCHOOL OF MINES.

In order to retain the advantages of the elective system, whereby the student may choose his work along the line for which he seems best fitted, and at the same time to be certain that every man shall have a well-rounded course, the following group system has been adopted for regular undergraduate students.

The first two years' work is common to all courses. At the beginning of the third year, the student elects between Mining, Metallurgy, Geology and Ceramics, and with a further choice between metal-mining, coal-mining, and the mining of oil and gas, and between general metallurgy and the metallurgy of iron and steel.

It will be noted that the course in Surveying is given in the summer term of the Freshman year. This leaves two full summers for practical work in mine, mill or smelter, or in the oil field, according to the option chosen by the student. This practical or cooperative work is a very important feature of the course, and is required in all cases.

COURSE IN MANAGEMENT.

Recognizing that, in a four years' course in mining, metallurgy or ceramics, the student cannot expect to get more than the fundamentals of the profession; and further, that there is need for men trained along managerial lines, a fifth or post-graduate year is offered, leading to the degree of Master of Science, with the idea that men taking this course will be fitted for work as executives.

Each application for admission to the course in Management will be decided upon its own merits. In general, however, graduation from a recognized technical school, supplemented by at least one year's practical work, will be necessary for admission.

A further description of this course will be found on page 23.

EVENING COURSES.

During the past year, short courses in general metallurgy, the metallurgy of iron and steel, metallography, and oil and gas mining, were given with success; similar courses will be offered the coming year.

EXTENSION DEPARTMENT.

The following short courses have been arranged for practical men who cannot afford the time to take a regular course:

1. For practical miners who desire to prepare for examination for fire-bosses;

2. For fire-bosses who wish to secure a mine foreman's certificate;
3. For those desiring to prepare for the mine inspector's examination;
4. For mine electricians.

Further description will be found on page 23.

Those who satisfactorily complete any of these courses will receive certificates of proficiency.

When these courses were offered, it was found that the men, after working all week, would not come to the University for instruction. A special instructor was, therefore, assigned to this department, and the classes organized at the mines.

This phase of the work of the School of Mines will be developed as rapidly as practicable, the intention being to have classes so distributed that any miner in the Pittsburgh district who wishes to take advantage of this opportunity to increase his knowledge, may readily do so.

OUTLINE OF COURSES.

Group I—Mining. Leads to degree of Engineer of Mines.

Option (a), General Mining.

Option (b), Coal Mining.

Option (c), Oil and Gas Mining.

Group II—Metallurgy. Leads to degree of Metallurgical Engineer.

Option (a), General Metallurgy.

Option (b), Metallurgy of Iron and Steel.

Group III—Geology. Leads to degree of Geological Engineer.

Group IV—Ceramics. Leads to degree of Ceramic Engineer.

FRESHMAN YEAR

REQUIRED IN GROUPS I, II, III, IV.

FALL TERM

No.	Subject	Class	Lab.	Credits	See Page
Math. 11	Advanced Algebra	5	0	5	27
Chem. 4	Inorganic Chemistry	2	6	4	28
Gr. 3-a	Mechanical Drawing	0	6	2	29
En. 4	English Composition	4	0	4	24
Ger. or Rom.	German, French or Spanish	3	0	3	25
Phys. Ed. 1	Physical Education	0	3	1	..
		14	15	19	..

WINTER TERM

Math. 12	Plane and Spher. Trig.	5	0	5	27
Chem. 5	Inorganic Chemistry	2	6	4	28
Gr. 5	Descriptive Geometry	2	6	4	30
En. 5	English Composition	4	0	4	24
Ger. or Rom.	German, French or Spanish	3	0	3	25
Phys. Ed. 2	Physical Education	0	3	1	..
		16	15	21	..

SPRING TERM

Math. 13	Analytic Geometry	5	0	5	27
Chem. 6	Inorganic Chemistry	2	6	4	28
Gr. 3-a	Mechanical Drawing	0	9	3	29
En. 6	English Composition	3	0	3	24
Ger. or Rom.	German, French or Spanish	3	0	3	25
Phys. Ed. 3	Physical Education	0	3	1	..
		13	18	19	

SUMMER TERM

C. E. 22	Surveying—50 hours per week for 10 weeks—20 credits. (See page 31).
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SOPHOMORE YEAR

REQUIRED IN GROUPS I, II, III, IV.

FALL TERM

No.	Subject	Class	Lab.	Credits	See Page
Math. 14	Calculus	5	0	5	27
Chem. 20	Qual. and Quant. Analysis	2	6	4	28
Phys. 11	Physics	4	3	5	29
Geol. 1	General Geology	3	0	3	38
Miner. 2	Crystallography and Mineralogy	2	6	4	37
Phys. Ed. 4	Physical Education	0	3	1	..
		16	18	22	..

WINTER TERM

Math. 15	Calculus	5	0	5	27
Chem. 21	Qual. and Quant. Analysis	2	6	4	28
Phys. 12	Physics	4	3	5	29
Geol. 2	Stratigraphical Geology	3	0	3	38
Miner. 3	Mineralogy	2	6	4	37
Phys. Ed. 5	Physical Education	0	3	1	..
		16	18	22	..

SPRING TERM

Chem. 22	Qual. and Quant. Analysis	2	6	4	28
Phys. 13	Physics	4	3	5	29
Mech. 1	Analytic Mechanics	5	0	5	30
Geol. 3	Structural & Field Geology	3	6	5	38
Miner. 4	Mineralogy & Lithology	2	6	4	37
Phys. Ed. 6	Physical Education	0	3	1	..
		16	24	24	..

JUNIOR YEAR ,GROUP I—a and b

No.	Subject	FALL TERM			See
		Class	Lab.	Credits	Page
Mech. 2	Mechanics of Material	5	0	5	30
Mech. 3	Mechanical Laboratory	0	6	2	30
Mech. 4	Graphic Statics	1	6	3	31
Ec. Geol. 1	Economic Geology	3	0	3	39
Mine 1	Principles of Mining	3	0	3	41
Met. 1-a	General Metallurgy	3	0	3	45
Met. 1-b	Metallurgical Laboratory	0	3	1	45
Met. 4	Ore Dressing	3	0	3	46
Insp. 1	Inspection Trips	..	..	1	49

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WINTER TERM					
E. E. 2	Applied Electricity	2	3	3	33
Ec. Geol. 2	Economic Geology	3	0	3	39
Mine 2	Principles of Mining	3	0	3	41
Mine 11	Underground Surveying	2	3	3	42
Met. 2-a	General Metallurgy	3	0	3	45
Met. 2-b	Metallurgical Laboratory	0	6	2	45
Met. 5	Ore Dressing	3	0	3	46
Ec. 3-e	Economic Theory	3	0	3	34
Insp. 2	Inspection Trips	..	..	1	49

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SPRING TERM					
M. E. 4	Prime Movers	2	3	3	33
S. E. 1	Hydro-Mechanics and Hy-				
	draulics	5	0	5	33
S. E. 2	Hydraulic Laboratory	0	3	1	34
Ec. Geol. 3	Economic Geology	3	0	3	39
Mine 3	Practice of Mining (Ore)	3	0	3*	42
Mine 7	Practice of Mining (Coal)	3	0	3†	42
Mine 26	Mine Laboratory	0	3	1	44
Met. 3-a	General Metallurgy	3	0	3	45
Met. 3-b	Metallurgical Laboratory	0	3	1	45
Met. 6	Ore Dressing (Stamp-				
	Milling)	3	0	3*	46
Met. 23	Ore Dressing (Coal Washing)	3	0	3†	47
Insp. 3	Inspection Trips	..	..	1	49

* Option (a).

† Option (b).

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SENIOR YEAR, GROUP I—a and b

No.	Subject	FALL TERM			See Page
		Class	Lab.	Credits	
C. E. 23	Masonry, Concrete, etc.	3	6	5	32
Mine 4	Practice of Mining (Ore)	3	0	3*	42
Mine 8	Practice of Mining (Coal)	3	0	3†	42
Mine 16	Coke Manufacture	2	0	2†	43
Mine 17	Placer Mining	2	0	2*	43
Mine 18	Mining Costs and Mine Manage-				
	ment	3	0	3	43
Mine 23	Seminar	1	0	1	44
Mine 27	Mining Laboratory	0	6	2	44
Met. 24	Fire Assaying	1	6	3	47
Insp. 4	Inspection Trips	..	..	1	49
	Electives	..	..	2	..
				22	
WINTER TERM					
Mine 5	Practice of Mining (Ore)	3	0	3*	42
Mine 9	Practice of Mining (Coal)	3	0	3†	42
Mine 13	Mine Plant Design	1	6	3	43
Mine 19	Mining Costs and Mine Manage-				
	ment	3	0	3	43
Mine 21	Mining Law	2	0	2	43
Mine 24	Seminar	1	0	1	44
Mine 28	Mining Laboratory	0	6	2	44
Insp. 5	Inspection Trips	..	..	1	49
	Electives	..	..	7	..
				22	
SPRING TERM					
Ec. 46	Contracts and Specifications	3	0	3	36
Mine 6	Practice of Mining (Ore)	3	0	3*	42
Mine 10	Practice of Mining (Coal)	3	0	3†	42
Mine 14	Mine Plant Design	1	6	3	43
Mine 15	First Aid and Mine Rescue				
	Work	0	6	2	43
Mine 20	Mine Valuation	2	0	2	43
Mine 22	Mining Law	2	0	2	43
Mine 25	Seminar	1	0	1	44
Mine 29	Mining Laboratory	0	6	2	44
Insp. 6	Inspection Trips	..	..	1	49
	Electives	..	..	3	..
Insp. 7	Three Weeks' Field Trip	..	..	6	50

* Option (a).

† Option (b).

It is suggested that students elect Ec. 13, 16, 19, or Ec. 21, 24, 27.

JUNIOR YEAR, GROUP 1-c

FALL TERM

No.	Subject	Class	Lab.	Credits	See Page
Chem. 40	Organic Chemistry	2	6	4	29
Mech. 2	Mechanics of Materials	5	0	5	30
Mech. 3	Mechanical Laboratory	0	6	2	30
Geol. 4	Geological Methods	2	0	2	38
Ec. Geol. 1	Economic Geology	3	0	3	39
Oil 1	Geology of Oil and Gas	2	0	2	44
Oil 4	Oil and Gas Laboratory	0	3	1	44
Oil 15	Seminar	1	0	1	45
Mine 1	Principles of Mining	3	0	3	41
Insp. 1	Inspection Trips	..	..	1	49

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WINTER TERM

E. E. 2	Applied Electricity	2	3	3	33
Geol. 5	Geology of Western Penna.	2	0	2	38
Ec. Geol. 2	Economic Geology	3	0	3	39
Oil 2	Geology of Oil and Gas	2	0	2	44
Oil 5	Oil and Gas Laboratory	0	9	3	44
Oil 16	Seminar	1	0	1	45
Mine 2	Principles of Mining	3	0	3	41
Insp. 2	Inspection Trips	..	..	1	49
Ec. 3-e	Economic Theory	3	0	3	34

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SPRING TERM

M. E. 4	Prime Movers	2	3	3	33
S. E. 1	Hydro-Mechanics and Hy- draulics	5	0	5	33
S. E. 2	Hydraulic Laboratory	0	3	1	34
Geol. 6	Geology of North America	2	0	2	38
Ec. Geol. 3	Economic Geology	3	0	3	39
Oil 3	Geology of Oil and Gas	2	0	2	44
Oil 6	Oil and Gas Laboratory	0	9	3	44
Oil 17	Seminar	1	0	1	45
Insp. 3	Inspection Trips	..	..	1	49

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SENIOR YEAR, GROUP I-c

FALL TERM

No.	Subject	Class	Lab.	Credits	See Page
C. E. 23	Masonry, Concrete, etc.	3	6	5	32
Oil 10	Production of Oil and Gas	2	0	2	45
Oil 7	Oil and Gas Laboratory	0	6	2	44
Oil 18	Seminar	1	0	1	45
Mine 18	Mining Costs and Mine Man- agement	3	0	3	43
Ec. 47	Principles of Accounting	1	2	2	36
	Electives to total 22 credits*	..	..	7	..
					22

WINTER TERM

Oil 11	Production of Oil and Gas	2	0	2	45
Oil 8	Oil and Gas Laboratory	0	6	2	44
Oil 19	Seminar	1	0	1	45
Mine 19	Mining Costs and Mine Man- agement	3	0	3	43
Mine 21	Mining Law	2	0	2	43
Ec. 48	Principles of Accounting	1	2	2	36
	Electives to total 22 credits*	..	..	10	..
					22

SPRING TERM

Oil 12	Production of Oil and Gas	2	0	2	45
Oil 13	Examination of an Oil or Gas Property	0	6	2	45
Oil 14	Petroleum Refining	1	6	3	45
Oil 20	Seminar	1	0	1	45
Mine 15	First Aid and Mine Rescue Work	0	6	2	43
Ec. 46	Contracts and Specifications	3	0	3	36
Ec. 49	Principles of Accounting	1	2	2	36
	Electives*	..	..	7	..
Insp. 7	Field Trip	..	..	6	50
					28

*It is suggested that students elect Ec. 13, 16, 19, 21, 24, 27, Ec. Geol. 4 and Min. 11, 20, 22.

JUNIOR YEAR, GROUP II.

FALL TERM

No.	Subject	Class	Lab.	Credits	See Page
Chem. 10	Advanced Inorganic Chemistry	2	0	2	28
Mech. 2	Mechanics of Materials	5	0	5	30
Mech. 3	Mechanical Laboratory	0	6	2	30
Mech. 4	Graphic Statics	1	6	3	31
Mine 1	Principles of Mining	3	0	3	41
Met. 1-a	General Metallurgy	3	0	3	45
Met. 1-b	Metallurgical Laboratory	0	6	2	45
Met. 4	Ore Dressing	3	0	3	46
Insp. 1	Inspection Trips	..	..	1	49

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WINTER TERM

Chem. 11	Advanced Inorganic Chemistry	2	0	2	28
E. E. 2	Dynamos and Motors	2	3	3	33
Mine 2	Principles of Mining	3	0	3	41
Met. 2-a	General Metallurgy	3	0	3	45
Met. 2-b	Metallurgical Laboratory	0	6	2	45
Met. 5	Ore Dressing	3	0	3	46
Ec. 3-e	Economic Theory	3	0	3	34
Insp. 2	Inspection Trips	..	..	1	49

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SPRING TERM

Chem. 12	Advanced Inorganic Chemistry	2	0	2	28
M. E. 4	Prime Movers	2	3	3	33
S. E. 1	Hydromechanics and Hydraulics	5	0	5	33
S. E. 2	Hydraulic Laboratory	0	3	1	34
Met. 3-a	General Metallurgy	3	0	3	45
Met. 3-b	Metallurgical Laboratory	0	6	2	45
Met. 6 or 23	Ore Dressing	3	0	3	46
Insp. 3	Inspection Trips	..	..	1	49

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SENIOR YEAR, GROUP II.

FALL TERM

No.	Subject	Class	Lab.	Credits	See Page
Met. 7	Principles of Metallurgy	1	6	3	46
Met. 16	Metallurgy of Copper, Lead, the Minor Metals	4	0	4*	46
Met. 13	Metallurgy of Iron and Steel	4	0	4†	46
Met. 24	Assaying	1	6	3	47
Met. 36	Current Literature	1	0	1	48
	Electives in Metallurgy	..	..	5	..
	Other Electives	..	..	6	..
					22

WINTER TERM

Met. 8	Principles of Metallurgy	3	0	3	46
Met. 17	Metallurgy of Copper, Lead, the Minor Metals	4	0	4*	46
Met. 14	Metallurgy of Iron and Steel	4	6	6†	46
Met. 25	Assaying	0	6	2*	47
Met. 37	Current Literature	1	0	1	48
	Electives in Metallurgy	..	..	6	..
	Other Electives	..	..	6	..
					22

SPRING TERM

Ec. 46	Contracts and Specifications	3	0	3	36
Met. 9	Principles of Metallurgy	3	0	3	46
Met. 18	Metallurgy of Copper, Lead, the Minor Metals	4	0	4*	46
Met. 15	Metallurgy of Iron and Steel	4	0	4†	46
Met. 38	Current Literature	1	0	1	48
	Electives	..	..	11	..
Insp. 7	Field Trip	..	..	6	50
					28

* Option (a). † Option (b).

It is suggested that students elect Ec. 13, 16, 19 or Ec. 21, 24, 27.

JUNIOR YEAR, GROUP III.

FALL TERM

No.	Subject	Class	Lab.	Credits	Sec Page
Mech. 2	Mechanics of Materials	5	0	5	30
Mech. 3	Mechanical Laboratory	0	6	2	30
Geol. 4	Geological Methods	2	0	2	38
Ec. Geol. 1	Economic Geology	3	0	3	39
Min. 7	Petrography	1	6	3	37
Mine 1	Principles of Mining	3	0	3	41
Met. 1-a	General Metallurgy	3	0	3	45
Met. 1-b	Metallurgical Laboratory	0	3	1	45
Insp. 1	Inspection Trips	..	..	1	49

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WINTER TERM

Geol. 5	Geology of Western Penna.	2	0	2	38
Ec. Geol. 2	Economic Geology	3	0	3	39
Min. 8	Petrography	1	6	3	37
Mine 2	Principles of Mining	3	0	3	41
Mine 11	Underground Surveying	2	3	3	42
Met. 2-a	General Metallurgy	3	0	3	45
Met. 2-b	Metallurgical Laboratory	0	6	2	45
Insp. 2	Inspection Trips	..	..	1	49

20

SPRING TERM

S. E. 1	Hydro-Mechanics and Hy- draulics	5	0	5	33
S. E. 2	Hydraulic Laboratory	0	3	1	34
Geol. 6	Geology of North America	2	0	2	38
Ec. Geol. 3	Economic Geology	3	0	3	39
Min. 9	Petrography	1	6	3	37
Met. 3-a	General Metallurgy	3	0	3	45
Met. 3-b	Metallurgical Laboratory	0	6	2	45
Insp. 3	Inspection Trips	..	..	1	49

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SENIOR YEAR, GROUP III,

FALL TERM

No.	Subject	Class	Lab.	Credits	See Page
Pal. 1	Invertebrate Paleontology	2	6	4	39
Ec. Geol. 13	Seminar	1	0	1	40
Oil 1	Geology of Oil and Gas	2	0	2	44
Mine 17	Placer Mining	2	0	2	43
	Electives in Economic Geology	..	..	6	..
	Other Electives	..	..	7	..
					22

WINTER TERM

Pal. 2	Invertebrate Paleontology	2	6	4	39
Ec. Geol. 14	Seminar	1	0	1	40
Oil 2	Geology of Oil and Gas	2	0	2	44
Mine 21	Mining Law	2	0	2	43
	Electives in Economic Geology	..	..	6	..
	Other Electives	..	..	7	..
					22

SPRING TERM

Pal. 3	Invertebrate Paleontology	2	6	4	39
Ec. Geol. 15	Seminar	1	0	1	40
Oil 3	Geology of Oil and Gas	2	0	2	44
Mine 22	Mining Law	2	0	2	43
Mine 20	Mine Valuation	2	0	2	43
	Electives in Economic Geology	..	..	5	..
	Other Electives	..	..	6	..
Insp. 7	Field Trip	..	..	6	50
					28

JUNIOR YEAR, GROUP IV.

FALL TERM

No.	Subject	Class	Lab.	Credits	Sec Page
Mech. 2	Mechanics of Materials	5	0	5	30
Mech. 3	Mechanical Laboratory	0	6	2	30
Mech. 4	Graphic Statics	1	6	3	31
Ec. Geol. 1	Economic Geology	3	0	3	39
Mine 1	Principles of Mining	3	0	3	41
Cer. 1	Investigation & Testing of Clays	1	6	3	48
Cer. 4	Technology of Clays	2	0	2	48
Insp. 1	Inspection Trips	..	..	1	49
					22

WINTER TERM

Ec. 3-e	Economic Theory	3	0	3	34
Chem. 24	Advanced Quantitative Analysis	2	6	4	29
E. E. 2	Dynamos and Motors	2	3	3	33
Ec. Geol. 2	Economic Geology	3	0	3	39
Mine 2	Principles of Mining	3	0	3	41
Cer. 2	Investigation & Testing of Clays	1	6	3	48
Cer. 5	Technology of Clays	2	0	2	48
Insp. 2	Inspection Trips	..	..	1	49
					22

SPRING TERM

Chem. 25	Advanced Quantitative Analysis	2	6	4	29
M. E. 4	Prime Movers	2	3	3	33
S. E. 1	Hydromechanics and Hydraulics	5	0	5	33
S. E. 2	Hydraulic Laboratory	0	3	1	34
Ec. Geol. 3	Economic Geology	3	0	3	39
Cer. 3	Investigation & Testing of Clays	1	6	3	48
Cer. 6	Technology of Clays	2	0	2	48
Insp. 3	Inspection Trips	..	..	1	49
					22

SENIOR YEAR, GROUP IV.

FALL TERM

No.	Subject	Class	Lab.	Credits	See Page
Met. 1-a	General Metallurgy	3	0	3	45
Met. 1-b	Metallurgical Laboratory	0	3	1	45
Cer. 10	Pottery and Porcelain	2	0	2	49
Cer. 13	Ceramic Laboratory	0	15	5	49
Cer. 17	Seminar	1	0	1	49
Cer. 20	Plant Design	1	6	3	49
	*Electives	..	..	7	..
				22	

WINTER TERM

Met. 2-a	General Metallurgy	3	0	3	45
Met. 2-b	Metallurgical Laboratory	0	3	1	45
Cer. 11	Pottery and Porcelain	2	0	2	49
Cer. 14	Ceramic Laboratory	0	15	5	49
Cer. 18	Seminar	1	0	1	49
Cer. 21	Plant Design	1	6	3	49
	*Electives	..	..	7	..
				22	

SPRING TERM

Ec. 46	Contracts and Specifications	3	0	3	36
Met. 3-a	General Metallurgy	3	0	3	45
Met. 3-b	Metallurgical Laboratory	0	3	1	45
Cer. 12	Pottery and Porcelain	2	0	2	49
Cer. 15	Ceramic Laboratory	0	15	5	49
Cer. 19	Seminar	1	0	1	49
	*Electives	..	..	7	..
				22	

*It is suggested that students elect Ec. 13, 16, 19 or Ec. 21, 24, 27.

POST-GRADUATE YEAR.

(See page 9 for announcement.)

In this course the individual student will, necessarily, be allowed some latitude in his choice of work, depending upon his training and experience, and depending also upon whether he wishes to confine his investigation work to mines or mills of the types found in this district, or to work further afield.

In the fall term the class-room work will be mainly in elementary psychology, sociology and economics, and the theory of management, considerable time being allowed the student to study conditions and systems in the mines and mills of the Pittsburgh region.

The winter term is spent entirely in the field, each man being given an outline of work to follow, so that he may be able to ascertain what are the difficulties which confront the average superintendent or manager, and how these are met. He is required to make a weekly report to the school, in order that his work may be closely followed up and proper suggestions made to him.

At the beginning of the spring term he returns to the school, where he takes more advanced economics, etc., and works up into proper shape for presentation the data gathered during the fall and winter terms.

As indicated above, this schedule is variable, the endeavor being to fit the course to the individual student, rather than the student to the course. Those interested should write to the Dean for further information.

EXTENSION COURSES.

(See page 9 for announcement.)

1. Course arranged for men desirous of a fire-boss' certificate includes the following subjects:

Mine Gases and Explosions.

Mine Ventilation,

Mining Law,

Mine Accidents and their Prevention.

2. Course arranged for men desirous of a foreman's certificate includes the following subjects:

Methods of Working,

Mine Drainage and Pumping,

Haulage and Hoisting,

Recovering Coal Mines after Explosions and Fires.

Must be preceded by course 1 or its equivalent.

Engines and Boilers,
Principles of Chemistry,
Elementary Electricity,
Mine Economics or
Compressed Air in Mining.
Must be preceded by courses 1 and 2 or their equivalent.

Electricity in Mines,
Elementary Electricity,
Engines and Boilers,
Mine Gases and Explosions or
Mine Accidents and their Prevention.

The following include the required courses in the School of Mines, together with such electives as it was thought might be chosen by students of the School. For further studies which are open as electives, see the general catalog of the University.

PROFESSOR GIBBS AND DR. SNOW

[illegible]

Required of all Freshmen.

DR. SNOW

Spring Term, 3 credits

Required of all Freshmen.

7. ARGUMENTATION AND DEBATING

PROFESSOR GIBBS AND MR. Fall and Winter Terms, each 2 credits

The theory of argumentation, with practical exercises in brief-drawing and the composition and the delivery of forensics.

Elective for students who have taken Courses 4, 5, 6.

15. AMERICAN LITERATURE

PROFESSOR GIBBS

Winter Term, 2 credits

A study of selected masterpieces representing the successive periods of American literature, with a textbook to furnish a historical background and connections.

Elective for students who have taken Courses 4, 5, 6.

German Language and Literature.

PROFESSORS BERGER AND CAMPBELL AND DR. BURDICK

1, 2, 3. ELEMENTARY GERMAN

PROFESSOR CAMPBELL AND DR. BURDICK

Fall, Winter and Spring Terms, 3 credits each term

Elements of grammar and the reading of easy texts. Prokosch, *German for Beginners*, *Deutsches Lese- und Uebungsbuch*; Allen, *Daheim*; Gerstacker, *Germelshausen*; Baumbach, *Der Schwiegersohn*.

4, 5, 6. INTERMEDIATE COURSE

PROFESSOR BERGER AND DR. BURDICK

Fall, Winter and Spring Terms, 3 credits each term

Review of grammar. Drill in translating from English into German and practice in conversation. Wesselhœft, *German Exercises*; Gæbel, *Hermann der Cherusker*; Wildenbruch, *Der Letzte*; Arnold, *Einst im Mai*; Schrakamp, *Deutsche Heimat*; Schiller, *Maria Stuart*.

Prerequisite, Courses 1-3 or two years of High School German.

T 7, 8, 9. TECHNICAL GERMAN for Engineering and Mining Students.

DR. BURDICK

Fall, Winter and Spring Terms, 3 credits each term

The work of the students will consist largely of the study of technical texts, as Wallentin, *Grunzuege der Naturlehre*; Blochman, *Scientific German*; Kayser, *Die Elektronen Theorie*; Lassar-Cohn, *Die Chemie im taeglichen Leben*; articles selected from the best *German Technical Journals*, etc.

Prerequisite, Courses 1-3, or two years of High School German.

Romance Languages and Literature

PROFESSOR HARRY, MR. SHELTON, MR. PIERUCCI, AND DR. BOYCE

1, 2, 3. ELEMENTARY FRENCH

MR. SHELTON Fall, Winter and Spring Terms, 3 credits each

Fraser and Squair's Grammar. Composition and easy reading, with thorough drill in pronunciation and practice in speaking.

4, 5, 6. INTERMEDIATE FRENCH

MR. SHELTON Fall, Winter and Spring Terms, 3 credits each

Extensive reading in selected works of Modern French writers. Fraser and Squair's Grammar completed. Advanced prose composition. French conversation. The following texts are read: Daudet, *Contes Choisis*; Maupassant, *Contes*; About, *Le Roi des Montagnes*; Coppée, *On Rend l'Argent*; Augier, *Le Gendre de M. Poirier*; George Sand, *La Mare au Diable*; Canfield's French Lyrics.

7, 8, 9. TECHNICAL FRENCH

PROFESSOR HARRY Fall, Winter and Spring Terms, 3 credits each

Dike's Scientific Reader and other works of similar character will be read. Reports from technical periodicals. The purpose of this course is to enable students to use Scientific French readily, and is primarily designed for students in Engineering courses who have a good reading knowledge of French prose of ordinary difficulty. *French Daily Life* is used as a textbook for conversation in French.

30, 31, 32. ELEMENTARY SPANISH

DR. BOYCE Fall, Winter and Spring Terms, 3 credits each term

Hill's and Ford's *Spanish Grammar*, reading, composition, conversation. Bransby's *Spanish Reader*, Selgas, *La Mariposa Blanca*; Galdos, *Dona Perfecta*; Tamayo, *Lo Positivo*; Giese's *Spanish Anecdotes*.

35, 36, 37. COMMERCIAL SPANISH

DR. BOYCE Fall, Winter and Spring Terms, 3 credits each term

Reading of Commercial Spanish. Commercial correspondence. Conversation. The vocabulary of everyday life is emphasized.

40, 41, 42. ELEMENTARY ITALIAN

DR. PIERUCCI Fall, Winter and Spring Terms, 3 credits each term

Elementary grammar, dictation, reading, memorizing, conversation, and easy composition. Motti's *Elementary Italian Grammar*. Cattaneo,

Italian Reader. De Amicis, *Cuore*. Other selections from modern authors will be assigned by the instructor.

43, 44, 45. ITALIAN, INTERMEDIATE COURSE

DR. PIERUCCI Fall, Winter and Spring Terms, 3 credits each term

Study of the Italian Grammar in Italian. Conversation and advanced prose composition. Italian literature of the XVIII and XIX centuries. Selected readings and brief lectures in Italian. Manzoni, *I Promessi Sposi*, will be read in full.

Open to students who have taken the course in Elementary Italian.

Mathematics.

DR. WEBBER AND MR. FORAKER

II. ALGEBRA

MR. FORAKER

Freshman Year, Fall Term, 5 credits

Theory of quadratics with graphical representations, mathematical induction, binomial theorem for any exponents, progressions, logarithms, permutations and combinations, probability, complex numbers, determinants, partial fractions, infinite series, theory of equations.

12. PLANE AND SPHERICAL TRIGONOMETRY

MR. FORAKER

Freshman Year, Winter Term, 5 credits

Goniometry, trigonometric equations, solution of right and oblique triangles and applications.

Theory and solution of right and oblique spherical triangles and their practical applications.

13. ANALYTIC GEOMETRY

MR. FORAKER

Freshman Year, Spring Term, 5 credits

Straight line, circle, transformation of co-ordinates, conic sections, general equation of the second degree, etc.

14. DIFFERENTIAL CALCULUS

DR. WEBBER

Sophomore Year, Fall Term, 5 credits

Differentiation, expansion of functions, maxima and minima, partial derivatives, tangents and normals, radius of curvature, etc.

15. INTEGRAL CALCULUS

DR. WEBBER

Sophomore Year, Winter Term, 5 credits.

Different methods of integration; application to curves, surfaces, volumes, moments of inertia, center of gravity, fluid pressure, force of attraction, etc.

Chemistry.

PROFESSOR SILVERMAN AND ASSISTANTS

4, 5, 6. GENERAL INORGANIC CHEMISTRY

PROFESSOR SILVERMAN AND MESSRS. WEIRICH, O'CALLAHAN, HESS, VAWTER, BLAKE, PADGETT, HUMPHREY, ROSE, RHODES AND NICOLET

Fall, Winter and Spring Terms, 4 credits each

A study of the metals and non-metals, principles, theories, and calculations. This course is intended for engineering and mining students who have not had chemistry in preparatory schools. Two lectures and two three-hour laboratory periods per week. A recitation is conducted at the beginning of each laboratory period. Freshman year.

7, 8, 9. GENERAL INORGANIC CHEMISTRY

PROFESSOR SILVERMAN AND MESSRS. WEIRICH, O'CALLAHAN, HESS, VAWTER, BLAKE, PADGETT, HUMPHREY, ROSE, RHODES AND NICOLET

Fall, Winter and Spring Terms, 3 credits each

A more advanced course than the preceding ones. This course is intended for students who have entrance credit in chemistry. One lecture, one recitation and one three-hour laboratory period per week. Freshman year.

10, 11, 12. ADVANCED INORGANIC CHEMISTRY

Fall, Winter, and Spring Terms, 2 credits each

This course supplements the work in Courses 7, 8, 9, which are prerequisite. It deals especially with the modern theories of chemistry. Two lectures per week. Required in Group II.

20, 21, 22. QUALITATIVE AND QUANTITATIVE ANALYSIS

DR. NEIDLE

Fall, Winter and Spring Terms, 4 credits each

A study of qualitative tests applied in detection of the more common elements and compounds followed by methods for separation of the various elements from each other. On completion of this work, the student is given instruction and practice in the exact or quantitative determination of some of the above elements by both gravimetric and volumetric methods. Modern ideas in inorganic and physical chemistry are applied. One lecture, one recitation and two three-hour laboratory periods per week. Prerequisites: 1, 2, 3. Sophomore year.

23. ADVANCED QUALITATIVE ANALYSIS

DR. NEIDLE

Fall Term, 4 credits

The physico-chemical basis of analytical chemistry is emphasized, and the laboratory work includes qualitative analyses of alloys, ores, paints, etc.

Two hours, lectures and recitations, and two three-hour laboratory periods per week. Prerequisite: 20, 21, 22.

24, 25. ADVANCED QUANTITATIVE ANALYSIS

DRS. VOGT AND CORLISS

Winter and Spring Terms, 4 credits each

The methods introduced in the elementary course are employed in complete quantitative analyses of ores, alloys and commercial products. Two hours, lectures and recitations, and two three-hour laboratory periods per week. Prerequisites: 20, 21, 22.

40, 41, 42. ORGANIC CHEMISTRY

DR. HITCH

Fall, Winter and Spring Terms, 4 credits each

An introduction to the chemistry of the compounds of carbon. The student is given an opportunity to prepare a large number of typical carbon compounds and study their properties, reactions, and uses. Two lectures and two three-hour laboratory periods per week. Prerequisites: 1, 2, 3; 20, 21, 22. Required in Group I-c.

Physics.

PROFESSOR BISHOP AND MR. ULREY

11, 12, 13. GENERAL PHYSICS

PROFESSOR BISHOP AND MR. ULREY

Fall, Winter and Spring Terms, 5 credits each term

First term, mechanics and heat; second term, electricity; third term, sound and light. In this course the calculus is extensively employed and special attention is given to the physical interpretation of mathematical equations.

A series of twelve lectures on the precision of measurements is given in connection with the laboratory work. Special attention is given in the laboratory to the method of the experiment and to the precision of the results.

Concurrent with Mathematics 14 and 15.

Sophomore year.

Graphics.

PROFESSOR LAMBIE

3-a. MECHANICAL DRAWING

Fall Term, 2 credits, Spring Term, 3 credits

The care and use of drafting instruments, instrument exercises, geometrical constructions, lettering, shading, exercises in drawing to scale, and dimensioning.

Orthographic projections, rotation of objects, oblique projections, intersections, and development of surfaces.

Isometric drawing and dimensioning, sectioning, and machine drawing.

Six hours per week in drafting room, Fall Term; nine hours per week, Spring Term. Freshman year.

5. DESCRIPTIVE GEOMETRY

Winter Term, 4 credits

A critical study of the science of representing by drawing. The location of points, lines, planes, single curved surfaces, surfaces of revolution, and warped surfaces, with their relations to each other; tangent lines and planes; intersection of surfaces; shades, shadows and perspective.

Two lectures and six hours in drafting room per week. Freshman year.

Mechanics

PROFESSORS WENRICH, CASE AND LAMBIE

1. ANALYTIC MECHANICS

PROFESSOR WENRICH

Spring Term, 5 credits

This subject comprises among its topics the composition and resolution of forces, the center of gravity, the moment of inertia, radius of gyration, laws of friction and of motion, projectiles, impact, machines, work, and energy. The solution of numerous problems in application of formulas is constantly required.

Five recitations and lectures per week. Sophomore year.

Prerequisite: Mathematics 15, Physics 12.

2. MECHANICS OF MATERIALS

PROFESSOR LAMBIE

Fall Term, 5 credits

The resistance and elasticity of materials. The action of beams under various conditions of fixity and loading; strength of columns and shafts; combined stresses; resilience of materials, etc.

Five recitations and lectures per week. Junior year.

Prerequisite: Mechanics 1.

3. MECHANICAL LABORATORY

PROFESSOR CASE

Fall Term, 2 credits

The experimental study of the physical properties of the materials of construction, such as iron and steel, wood, brick, stone, cement, and concrete.

Six laboratory hours per week. Junior year.

To be taken concurrently with Mechanics 2.

4. GRAPHIC STATICS

PROFESSOR CASE

Fall Term, 3 credits

The solution of problems in which the stresses in frame work, beams, roof and bridge trusses are ascertained by graphical methods. Methods for dead load, snow, wind, and live loads.

One lecture and six hours drawing per week. Junior year.

Prerequisites: Graphics 3a; Mechanics 1.

Civil Engineering

PROFESSOR LAMBIE AND MR. McCANDLISS

22. SURVEYING

MR. McCANDLISS

Summer Term, 20 credits

The course includes:

I. PRELIMINARY SURVEYING.—Pacing; ranging; preliminary location of mining claim and filing of notice of location; adjustment of Locke level; topographical survey of mining claim by pacing and hand level.

II. LAND SURVEYING.—Adjustment of compass; subdivision of land; farm survey; city survey; adjustment of solar attachments; official survey of mining claim.

III. TOPOGRAPHICAL SURVEYING.—Adjustment of transit; repetition traverse; azimuth traverse; adjustment of plane table instrument; topographical survey with plane table; topographical survey with transit and stadia; tying in of topographical survey to triangulation system.

IV. GEODETIC SURVEYING.—Measurements of base line; triangulation, including computations and adjustment of quadrilateral; adjustment of engineers' level; determination of elevation of bench marks and triangulation points by levelling; observation on Polaris with transit for determination of true azimuth.

V. RAILROAD SURVEYING.—Reconnaissance with clinometer and pocket compass; preliminary survey with transit, chain and engineers' level, topography by pacing and hand level; permanent location with transit, steel tape, and engineers' level; computation of simple and compound curves; setting curve and line stakes with transit and steel tape; profile levelling; plotting on profile sheet and establishment of grade; cross-sectioning; computation of cuts and fills; computing and laying in turnouts, frogs, switches and Y-junction curves.

Maps are required to be made of the mining claim pacing survey, the mining claim official survey, the azimuth and repetition traverses, the farm survey, the city survey, the stadia survey, and the railroad survey.

The class is divided into squads, each man being required to do every kind of work with every instrument used, make a full set of notes of the work done by his squad, and from those notes make the maps in the drawing room.

50 hours per week. Required of all students in the School of Mines.

23. ELEMENTS OF MASONRY AND CONCRETE CONSTRUCTION

PROFESSOR LAMBIE

Fall Term, 5 credits

This is an elementary course, designed to meet the needs of mining engineers. It comprises a brief outline of the theory, and a study of practical construction of: reinforced concrete beams and slabs, masonry and concrete foundations, retaining walls and arches. The laboratory exercises include the testing of cements, sand, gravel, mortar, and concrete specimens.

Three lectures, and six laboratory hours per week. Required in Group I.

Mechanical Engineering

PROFESSOR WEBER AND ASSISTANTS

(1a). ELEMENTARY MECHANICAL LABORATORY

Fall Term, 3 credits

The elementary study of casting design from the standpoint of moulding and founding. The student is required to mould a graded set of patterns, run off heats, and cast a number of representative test specimens from various metals. The lecture and recitation work covers the study of the properties of castings and the production of same on a commercial scale. Inspection trips are made to local foundries.

One lecture or recitation and six hours elementary laboratory work per week.

(2a). ELEMENTARY MECHANICAL LABORATORY

Winter Term, 3 credits

The elementary study of the treatment and properties of wrought iron, soft steel, and carbon tool steel. The student is required to forge and machine a number of representative test specimens which will bring out the characteristics and strength of materials. The lecture and recitation work covers the study of the properties of wrought metals, and the working and forging of same on a commercial scale. Inspection trips are taken to local industrial plants.

One lecture or recitation and six hours elementary laboratory work per week.

(3a) ELEMENTARY MECHANICAL LABORATORY

Spring Term, 3 credits

Machine elements and structural details are prepared and tested, and the results reported. The lecture and recitation work includes the discussion of the results of laboratory tests and the study of the elementary features of machine and structural design.

One lecture or recitation and six hours elementary laboratory work per week.

4. PRIME MOVERS

Spring Term, 3 credits

A brief study of the construction and operation of steam boilers, engines and turbines; and of gas engines and producers.

Two lectures and three laboratory hours per week. Junior year, Groups I, II and IV.

Prerequisites: Mechanics I; Physics 13.

Electrical Engineering

PROFESSOR HARRIS

Winter term, 3 credits

2. APPLIED ELECTRICITY

This is a short course designed to meet the requirements of those not specializing in Electrical Engineering.

Two lectures and recitations and three hours laboratory per week. Junior year, Groups I, II and IV.

Prerequisite: Physics 13.

Sanitary Engineering

PROFESSOR CASE

I. HYDRO-MECHANICS AND HYDRAULICS

Spring Term, 5 credits

The equilibrium and pressure of liquids; the motion and work of fluids; the flow of water through orifices, over weirs, in pipes, and in canals; measurement of water power; and hydraulic machinery.

Five recitations and lectures per week. Junior year.

Prerequisites: Mechanics I, Mathematics 15.

2. HYDRAULIC LABORATORY

Spring Term, 1 credit

The experimental study of the flow of water through pipes, nozzles, orifices, and over weirs. Capacity and efficiency tests of hydraulic turbine pumps and motors.

Three laboratory hours per week. Junior year.

To be taken concurrently with S. E. I.

Economics

PROFESSORS HOLDSWORTH AND FLOCKEN AND MESSRS. AND

3-e. ECONOMICS

PROFESSOR

Winter Term, 3 credits

A brief resume of economic theory. Discussion of practical economic problems; wages, interest, rent, currency, banking, taxation, trusts, tariff, socialism.

Textbooks and lectures. Junior year.

10, 11. TRANSPORTATION

Fall and Winter terms, 2 credits each term

The origin and growth of the American railways. Their present ownership and control. The organization of the railway company, and how it does its work. Railway financiering. The freight, passenger, express and mail service. Railway abuses. Regulation by the states and by the Federal Government. The Interstate Commerce Commission. Government ownership in the light of foreign experience. Railway rates and fares. Electric railway transportation.

13. MODERN INDUSTRIES

Fall Term, 2 credits

A study of the leading American industries, physiographic control, source and supply of raw material, agricultural resources. Factors affecting the location of industry. Sources and application of power. Manufacturing methods, and factors affecting cost of production. Large scale versus small scale production. Internal commerce and foreign trade. Lectures, assigned readings and reports.

16. INDUSTRIAL MANAGEMENT

Winter Term, 2 credits

Advantages of various methods of business organization and management. The internal management of the large business or plant and the

differentiation of the duties of various departments. Profit-sharing schemes. Labor problems. Markets and methods of distribution. A study of actual industrial conditions by visits to the mills and shops of Pittsburgh, special attention being given to the handling of raw material, the arrangements of plant, and shipping facilities. Lectures, assigned readings, reports, field work.

19. LABOR PROBLEMS

Spring Term, 3 credits

The characteristic features of American industry and immigration with reference to the supply of labor. The organization, machinery, and methods of the trade-union and the employers' association. The planning and conduct of strikes and boycotts. The open and the closed shop. Arbitration and conciliation. Industrial efficiency. Labor legislation. The Federal and State Laws and decisions relating to labor, the factory and sweatshop, and employer's liability. Textbook and assigned readings. Textbook, Adams and Summer's Labor Problems.

21. CORPORATION FINANCE

PROFESSOR HOLDSWORTH

Fall Term, 3 credits.

Types of business corporations. The genesis of the trust. The financial organization and management of corporations. The promoter and the underwriting syndicate. The disposition of gross earnings and the provision of new capital. Charter, articles and by-laws. Stockholders' powers, rights and liabilities. Dissolution, receiverships and reorganizations. Lectures and textbook, assigned readings and reports. Textbooks, Lough's Corporation Finance.

24. INVESTMENTS

PROFESSOR HOLDSWORTH

Winter Term, 3 credits

The general characteristics and merits of government and municipal bonds, and of railway, industrial, public service corporation, power irrigation securities. The farm and city mortgage. How securities are purchased and marketed. The organization of the investment business. A study of fluctuations in bond and stock prices to determine the influence acting upon security values. Analysis of typical securities and railroad reports. Examination of savings banks and trust company holdings. Lectures, assigned readings and reports.

27. BROKERAGE

PROFESSOR HOLDSWORTH

Spring Term, 3 credits

The organization and machinery of stock and produce exchanges. The terminology of the stock market. How stocks and bonds are listed and

dealt in. Speculation. Dealing in "futures." Bucket shops. The "curb". Investment brokerage. The relation of the stock exchange to the country and to the banks. The broker and his work. The legal relationship of broker and customer. Lectures and reports.

46. CONTRACTS AND SPECIFICATIONS

Spring Term, 3 credits

In this course are presented the essential elements of a contract, the law pertaining thereto and parties who may contract. The consideration, discharge and remedies for breach of contract. Forms of proposals, specifications and illustrative examples of complete contracts and specification for various engineering projects are given.

47, 48, 49. PRINCIPLES OF ACCOUNTING

PROFESSOR FLOCKEN Fall, Winter, and Spring Terms, 2 credits each term

A course covering the fundamental principles of accounting, including the principles and practice involved in the derivation of the income statement and balance sheet; the construction, use, and interpretation of these statements; a study of the various books used in accounting; opening and closing entries, and the special accountancy requirements of the sole proprietorship, partnership, and corporate forms of business organization.

Sociology.

I, 2, 3. THEORY OF SOCIOLOGY

Fall, Winter and Spring Terms, 2 credits each

This course includes a study of the development of sociology, its importance and place in the social sciences, and of the underlying biological, physical and psychical factors in sociology.

Psychology.

PROFESSOR WHITE

20. PSYCHOLOGY FOR STUDENTS IN THE SCHOOL OF MINES

Fall Term, 5 credits; Spring Term, 1 to 3 credits

A course designated to give

- (a) The general principles of psychology;
- (b) A general survey of the whole field of psychology;
- (c) Special applications to the problems of individual differences of character; race psychology; suggestion and choice, custom, convention-

ality, imitation, coöperation, competition; psychology of the gang, the crowd, the mob; psychology of responsibility; ownership, etc., etc.; psychology applied to everyday life.

This course is arranged for students taking the course in Management. Five lectures per week will be given in the fall term.

During the spring term the work will consist of conferences, at which will be discussed problems which have arisen during the field work of the winter term. This will be of great value to all who expect to become executives.

Mineralogy and Petrography

PROFESSOR LEIGHTON

1. GENERAL MINERALOGY

Fall Term, 2 credits

Designed primarily for civil engineering students but open to anyone desiring a brief course in the subject. About 75 minerals and a few common rocks are studied.

2, 3, 4. GENERAL MINERALOGY

Fall, Winter, and Spring Terms, 4 credits each term

Includes the subjects of crystallography, mineralogy and lithology. Required of all students in the School of Mines and open to any qualified student who desires a comprehensive knowledge of the subject. About 250 mineral species are studied and stress laid on the actual determination of unlabelled material. Sophomore year.

5. MATHEMATICAL CRYSTALLOGRAPHY

Winter Term, 2 credits

The calculation of axial ratios and other constants in crystals and the methods of projecting and drawing crystals.

Prerequisites: Math. 12; Min. 2, 3, 4.

6. ADVANCED MINERALOGY

Advanced or research work in crystallography, mineralogy or lithology. Primarily for graduate students, but open to all having sufficient training. Credits and courses to suit the needs of the student.

Prerequisites: Chem. 3, 4, 8; Min. 2, 3, 4.

7, 8, 9. PETROGRAPHY

Fall, Winter, and Spring Terms, 3 credits each term

Includes a study of optical crystallography, the optical determination of minerals, and the determination and classification of rocks by microscopic methods.

Required in Group III.

Prerequisite: Min. 2, 3, 4.

Designed to meet the needs of individual students.

GEOLOGY

PROFESSOR JOHNSON

1. DYNAMIC GEOLOGY

Fall Term, 3 credits

The general principles of geology exclusive of historical, structural and field geology. The probable origin of the earth, volcanic and earthquake activities, destructive and constructive work of air and water, etc. Sophomore year.

2. HISTORICAL GEOLOGY

Winter Term, 3 credits

The ancient life history of the earth. The successive continent outlines with the plant and animal life characteristic of the times. The distribution in time and space of volcanic activity, coal deposits, etc. Sophomore year.

3. STRUCTURAL AND FIELD GEOLOGY

Spring Term, 5 credits

This course is an effort to apply the general principles of geology in teaching the student how to interpret for himself the geologic significance of earth features and structure. Sophomore year.

4. GEOLOGICAL METHODS

Fall Term, 2 credits

A training course for men who intend to do original work in geology. Prerequisites: Geology 1, 2, 3. For graduates and undergraduates.

5. THE GEOLOGY OF WESTERN PENNSYLVANIA

Winter Term, 2 credits

Prerequisites: Geology 1, 2, 3. For graduates and undergraduates.

6. THE GEOLOGY OF NORTH AMERICA

Spring Term, 2 credits

Prerequisites: Geology 1, 2, 3. For graduates and undergraduates.

Work upon a series of problems adapted to the needs of the particular student or research in one problem. For graduates and undergraduates.

PALEONTOLOGY

PROFESSOR ORTMANN

1, 2, 3. GENERAL PALEONTOLOGY

Fall, Winter and Spring Terms, 4 credits each

This course is intended to present a general survey of the field of Invertebrate Paleontology. The work will consist of lectures and laboratory work, for which latter the rich resources of the Carnegie Museum provide splendid facilities. The ancient life history of the earth will be treated in broad outlines and the structure of the leading groups of fossil organisms elucidated with a view toward illustrating their lines of development. A first hand acquaintance will be gained with the more familiar types, and the foundation laid for taking up a more detailed study of the different groups of invertebrate animals. Wood's *Elementary Paleontology* will be used as a textbook, and the English edition of Zittel as a work of reference.

Required in Group III.

4, 5, 6. ADVANCED PALEONTOLOGY

Fall, Winter and Spring Terms, 2 credits each

This course supplements the instruction offered in Paleontology 1, 2, 3, and aims to give an intimate acquaintance with the structure, relations and geological history of the different groups of invertebrates, more especially those concerning which the field geologist is required to possess a good working knowledge. Students will be expected to do a considerable amount of reading along suggested lines, and may be called upon to prepare a written theme upon an assigned topic. Besides the lectures, reading and laboratory work, opportunity will be afforded during the year to take part in field excursions and collection trips. Grabau and Shimer's *North American Index Fossils* will be used with other standard works of reference.

Economic Geology

PROFESSOR LEIGHTON

1, 2, 3. ECONOMIC GEOLOGY

Fall, Winter and Spring Terms, 3 credits each term

The mode of occurrence, origin, distribution and uses of the non-metallic and metallic mineral resources are discussed, special attention being given to the deposits of the United States.

Prerequisites: Min. 2, 3, 4; Geol. 1, 2, 3.

Required in Groups I and III.

4. GEOLOGY OF COAL Fall Term, 3 credits
Must be preceded by or taken with Economic Geology, 1, 2, 3.

5. GEOLOGY OF THE IRON ORES Winter Term, 3 credits
Must be preceded by or taken with Economic Geology 1, 2, 3.

6. GEOLOGY OF THE COPPER ORES Spring Term, 3 credits
Must be preceded by or taken with Economic Geology 1, 2, 3.

13, 14, 15. SEMINAR

Fall, Winter and Spring Terms, 1 credit each term

The current periodicals and new publications are reviewed.

Must be preceded by or taken with Economic Geology 1, 2, 3.

Required in Group III.

MINING.

PROFESSORS MELLER AND BLACK, DR. WALLGREN, MR. ZIMMERMAN

The aim of the curriculum in Mining Engineering is to impart such knowledge as will enable the student to successfully carry through a mining enterprise. In order to conduct mining operations intelligently, he will be called upon as an engineer to employ the principles of mathematics, physics, and mechanics; the sciences of geology, mineralogy, chemistry and metallurgy; and the arts of civil, mechanical, and electrical engineering; he must also have capacity for organization and business management.

The principles, sciences, and arts mentioned are taught by specialists in the different departments, their particular application to Mining being specially emphasized.

Three lines of election are offered to the student:

The Mining of Coal.

The Mining of Metals and Stone.

The Mining of Petroleum and other Hydrocarbons (see Oil and Gas.)

Besides the courses under the heads mentioned, there are courses relating to business methods and the economics of mining, which deal with

the problems confronting the mine manager, operator, and financial agent. A knowledge of these subjects has usually been gained by experience alone in the active mining-field; but a number of carefully selected courses of this character are included in the curriculum of the school.

In connection with the department is a laboratory, equipped with the most modern machinery used in underground work, steam, air, and electricity being directly available as power.

Class instruction is supplemented, where possible, by visits to mines in the vicinity; by reference to mine maps, models, drawings, and descriptions of plants, etc.

1, 2. PRINCIPLES OF MINING

Fall and Winter Terms, 3 credits each term

This course is intended to give a resume of the principles of mining and is required of all students in the School. It is also to serve as a basis for subsequent study in the department. The course includes instruction in:

1. Modes of occurrence of minerals; as beds or seams, veins and masses.
2. Prospecting; aids, methods, outfits, etc.
3. Methods of entry; adit, drift, slope, shaft.
4. Exploitation: open cut and milling systems; underground methods of ore mining; methods of mining anthracite and bituminous coal; mining of other minerals.
5. Drilling and boring; purposes and methods of.
6. Explosives and their use.
7. Support of excavations: rock pillars, timber, masonry, brick-work, metallic supports.
8. Haulage: methods not involving the use of rails; railways, aerial ropeways.
9. Hoisting: motors, drums, pulley frames; ropes and rope attachments; receptacles, as buckets, cages, skips, safety appliances, etc.
10. Drainage: surface and mine.
11. Ventilation: pure air, constitution and requirements; mine air pollution; natural and artificial ventilation; testing mine air; accidents from mine gases, and their prevention; rescue and resuscitation; etc.
12. Lighting: candles; torches; lamps, oil, acetylene, electric.
13. Mine accidents and their prevention.

Visits of inspection are made to mines in the vicinity in order that the students may become familiar with the practical application of the principles discussed in the class-room. (See Inspection 1 and 2, Page 49)

3, 4, 5, 6. PRACTICE OF MINING (Ore). Group I-a.

7, 8, 9, 10. PRACTICE OF MINING (Coal). Group I-b.

Spring, Fall, Winter and Spring Terms, 3 credits each term

A continuation of Mine, 1, 2. Required of those electing Group I-a or b

Treats of the application of the principles covered in Mine 1, 2 to actual conditions. Engineering and economic features are emphasized.

At the beginning of the course each student is given all available information concerning a certain mining property which is to be opened and worked. He first prepares his topographic maps. After he has had instruction in the methods of entry to a mine he decides where the property in his problem is to be opened, the type of entry which is to be used, the method of excavation, support, etc. When he has had the class work in methods of working, he decides from the data at hand what method he will use for the extraction of the mineral on his property. Similarly he works out his haulage system, his hoisting system, his drainage system, ventilation, the surface arrangements of his plant, and, finally, the disposition of the product; the work of the student, as regards accuracy expected and independence of thought, being as nearly as possible the same as that required of a mining engineer in actual practice.

The aim is to require the student to make intelligent use of all that has gone before in his course in the School—his mathematics; his physics; chemistry; geology; civil, mechanical and electrical engineering, and so on. The problem assigned requires an average of six hours' work per week for four terms. (See Mine 26, 27, 28, 29, page 44). Each part as completed must be approved before the next part is taken up. The whole is finally bound and filed in the Mining department. To be accompanied by Inspection 3, 4, 5, 6.

11. UNDERGROUND SURVEYING

Winter Term, 3 credits

In this course are taught: The theory of underground practice in surveying; carrying the meridian underground by various methods, such as 2-wire, 3-wire, 4-wire, and with auxiliary telescope; survey of secondary openings, recording of survey, use of mine maps, etc. The three hours practical work per week are utilized by the student in acquiring familiarity with setting up under instead of over a point, and in sighting in the dark, use of the tape, plotting of notes, etc. Several days underground surveying are included in the Field Trip. (See page 49).

Required in Groups I-a, I-b, III.

12. MINE MAPPING

Spring Term, 3 credits

Making of maps from survey notes: plan, longitudinal and cross-sections of ore mine; plans of anthracite and bituminous coal mines.

13, 14. MINE PLANT DESIGN

Winter and Spring Terms, 3 credits each term

Design of surface structures, such as head-frame, ore-bins, tippie, boiler house, etc.

Required in Group 1-a and b.

15. FIRST AID AND MINE RESCUE WORK Spring Term, 2 credits

This course includes instruction in the following subjects: Bruises, Sprains, Fractures, Shock, Burns and Gas Poisoning, etc.; Principles, Design and use of the Helmet and Mouth-Breathing Devices, Resuscitation Apparatus, and in the Methods of Mine Rescue Work.

Required in Group I. Advised in Group II.

16. COKE MANUFACTURE Fall Term, 2 credits

A study of the physical properties and methods of manufacture of coke. The various types of ovens in use in this country and abroad are studied. Special attention is given to by-product ovens.

Required in Group 1-b.

17. PLACER MINING Fall Term, 2 credits

Occurrence of auriferous gravel deposits, methods of prospecting, development and working. Ground sluicing, river mining, drift mining, hydraulicking and dredging.

Required in Groups I-a and III.

18, 19. MINING COSTS AND MINE MANAGEMENT

Fall and Winter Terms, 3 credits each term

This course covers: Considerations which should precede the opening of mines, as topography, labor conditions, climate, transportation facilities, etc.; incorporation and capitalization; promotion of mining and exploration companies; investments in mines and mining stocks; reasons for failures in mining; mine administration; details of costs for operation, maintenance, depreciation and amortization, etc. Following this is a study of mining costs of representative companies in the various mining fields of the world.

Required in Group I.

20. MINE VALUATION Spring Term, 2 credits

A study of the factors which assist the engineer in determining the value of a producing mine or a prospect; conduct of the examination; report, etc.

Required in Groups I and III.

21, 22. MINING LAW

Winter and Spring Terms, 2 credits each term

A study of the Revised Statutes and subsequent Acts of Congress governing mining in the United States; State mining laws with especial reference to those of Pennsylvania.

Required in Groups I and III.

23, 24, 25. SEMINAR

Fall, Winter and Spring Terms, 1 credit each term

This course is given to familiarize the student with current technical literature.

Required in Group I-a and b. At intervals the Seniors in all groups meet together for discussion.

26, 27, 28, 29. MINING LABORATORY

Spring, Fall, Winter, and Spring Terms, 2 credits each term

To accompany Mine 3, 4, 5, 6 or 7, 8, 9, 10.

This time is allowed for working out the special problem referred to under Practice of Mining.

30, 31, 32. MINING LABORATORY

Credits vary

OIL AND GAS

PROFESSORS JOHNSON AND BROOKS

The courses in oil and gas are planned to equip men to (a) determine the relative chances of success in finding oil and gas by drilling at different points; (b) methods by which wells are most efficiently spaced, drilled and operated; (c) methods by which the business of oil and gas production is transacted; (d) methods of refining petroleum. So much of this work is done by crude and inefficient methods that a technical training in these lines greatly increases the efficiency of the worker as compared with the usual training by imitation alone. The practice in the summers is an important part of the work. In the first summer the student has surveying; in the second he works on an oil lease; in the third he will work as a geologic aid on the Federal or a State Survey, or again on the lease.

The regular course gives a balanced training, but for those who definitely plan to specialize in the geological, mechanical or refining phases the course may be modified toward that end.

1, 2, 3. GEOLOGY OF OIL AND GAS

Fall, Winter, and Spring Terms, 2 credits each term

Must be preceded by or taken with Geol. 4, 5, 6.

Required in Group I-c.

4, 5, 6, 7, 8, 9. OIL AND GAS LABORATORY

Credits vary

To accompany Oil and Gas 1, 2, 3, or 10, 11 and 12.

Experimentation in the role of gravitational sorting, capillarity and hydraulics in the accumulation of oil. Experience in using the geologic reports, maps and records of oil fields. Group I-c.

10, 11, 12. THE PRODUCTION OF OIL AND GAS

Fall, Winter, and Spring Terms, 2 credits each term

The production of oil and gas from the time the area has been chosen for prospecting. Leasing, disposition of wells, drilling, torpedoing, pumping, storage, transportation, sale.

The appraisal of oil and gas properties; management. General outline of the oil and gas industry.

Prerequisite: Oil and Gas 1, 2, 3.

Required in Group I-c.

13. THE EXAMINATION OF AN OIL OR GAS PROPERTY

Spring Term, 2 credits

The actual examination, and preparation of a report, with maps, of some accessible oil or gas property.

Prerequisite: Oil and Gas 1, 2, 3, 4, 5, 6, 10, 11, 12.

Required in Group I-c.

14. PETROLEUM REFINING

Spring Term, 3 credits

Required in Group I-c.

15, 16, 17, 18, 19, 20. SEMINAR IN OIL AND GAS

Fall, Winter, and Spring Terms, 1 credit each term

A weekly meeting to watch current oil and gas development and to consider the current literature. Required in Group I-c.

METALLURGY

PROFESSORS GOODALE, RAY, AND BROWN; MR. SIMPSON

1a, 2a, 3a. GENERAL METALLURGY

Fall, Winter, and Spring Terms, 3 credits each term

A general introductory course covering the metallurgical preparation and properties of the common metals. Text-book for fall and winter, Austin's Metallurgy of the Common Metals; for spring, Stoughton's Metallurgy of Iron and Steel.

Required of all students in School of Mines.

1b, 2b, 3b. GENERAL METALLURGY—LABORATORY

Fall, Winter, and Spring Terms, 2 credits each term

A laboratory course dealing with the methods of and apparatus for measurement of heat, thermal power of fuels, etc. Also a laboratory study of chemical and physical principles underlying metallurgy of common metals.

Required of all students in Group II. In Groups I, III, Fall Term, 1 credit; Winter and Spring, 2 credits. Group IV requires 1 credit all three terms.

4, 5, 6. ORE DRESSING AND STAMP MILLING

Fall, Winter, and Spring Terms, 3 credits each term

This course is designed to give the student the principles and practice of breaking and concentration of ores. Two terms are devoted to crushing, grinding, sizing, jigging and other methods of concentration, the underlying principles being studied in detail; and the third term to stamp milling and amalgamation. Text-book, Richard's Ore Dressing. Two terms are required of all students in the School of Mines, three for Group II-a, and three for Group I-a.

7, 8, 9. GENERAL METALLURGICAL PRINCIPLES

Fall Term, one lecture, 6 hours laboratory work; winter and spring terms, 2 recitations, 3 hours laboratory work. 3 credits each term.

This course comprises a study of metals, alloys, metallurgical materials and products, fuels, furnaces, measurements, etc. Text-book, Fulton's Principles of Metallurgy. Required in Group II.

10, 11, 12. METALLURGICAL CALCULATIONS

Fall, Winter, and Spring Terms, 4 credits each term

A study of the calculations relating to quantities of heat and material, and cost involved in furnace and other operations of metallurgy. Text book, Richard's Metallurgical Calculations. Elective, advised for all candidates for metallurgical degree. 10 is required for either 11 or 12, but 12 does not necessarily require 11.

13, 14, 15. IRON AND STEEL

Fall, Winter, and Spring Terms, 6 credits one term, 4 credits two terms

This course comprises a detail study of the blast furnaces, the open hearth and other steel furnaces, and the principles and practice of the manufacture of iron and steel. A number of visits of inspection to works are required during these courses. Text books, Forsythe's Metallurgy of Iron, Harbord and Hall Metallurgy of Steel. Required in Group II-b.

16, 17, 18. COPPER, LEAD, THE MINOR METALS

Fall, Winter, and Spring Terms, 4 credits each term

This course is intended to give a thorough knowledge of the metallurgy of copper, lead, and other common metals. Text books, Peter's Practice of Copper Smelting; Hofman's Metallurgy of Lead; Schnabel's Handbook of Metallurgy. 2 terms. Required in Group II-a.

19, 20, 21. ELECTRO-METALLURGY

Fall, Winter, and Spring Terms, 5 credits each term

A careful study of the electrothermic and electrolytic processes applied to the recovery and refining of metals. Text book, Allmand's Applied Electro-Chemistry. Three recitations and 6 hours laboratory work per week. Elective. The course is advanced work and requires a knowledge of chemistry, elementary electricity and metallurgy. This course takes up some of the most interesting and promising phases of metallurgy.

22. GOLD AND SILVER

1 term, 4 hours recitation per week, 4 credits

This course covers the metallurgy of gold and silver with special reference to the hydro or leaching processes such as cyanidation, the most important, chlorination, etc. The cyanide process is treated in detail on account of its present and growing importance. The refining of bullion by different methods is also thoroughly gone into. Elective, advised for candidates for metallurgical degree. Group II-a.

23. COAL WASHING

1 Term, 3 credits

The study of the preparation of anthracite and bituminous coal for the market or for special use. It includes crushing, picking, screening, jigging and other methods of washing. Required in Group I-b.

Prerequisite: Met. 4 and 5.

24, 25. FIRE ASSAYING

Fall Term, 3 credits; Winter Term, 2 credits

This course is designed to give the student a thorough theoretical and practical knowledge of the assaying of ores of gold, silver, and platinum by fire methods. Commercial laboratory methods giving speed of manipulation are taught, as well as more refined methods for special accuracy. Elective. Required in Group II-a. One term required in Group I, and in Group II-b.

26. MANGANESE, NICKEL, COBALT, VANADIUM, CHROMIUM, TUNGSTEN, ETC.

Any Term, 2 to 4 credits

A study of the manufacture, properties and uses of those metals that are of special interest in alloy steels. Elective.

Prerequisite: General knowledge of metallurgy.

27, 28, 29. METALLURGICAL DESIGN

Fall, Winter, and Spring Terms, 2 to 4 credits each term

Draughting room work in preparing plans for metallurgical machinery, plants, processes, etc. Elective.

Prerequisite: detailed study of the courses given referring to the problem undertaken.

30, 31. METALLOGRAPHY

2 Terms, 3 credits each

A study of metals and alloys, their structure, properties, etc. Laboratory work with the microscope, photo-micrography, testing, etc.

Junior or Senior year. Advised for Group II.

33, 34, 35. GENERAL LABORATORY WORK, ADVANCED

Any Term, 2 to 18 credits

Opportunity is given to the student to take up some problem of interest for detailed study and laboratory experimentation. Elective, open to advanced students.

36, 37, 38. REFERENCE WORK IN CURRENT LITERATURE

Fall, Winter, and Spring Terms, 1 credit each term

This course is to give the student familiarity with the technical press, and is required in Group II. Seniors in all groups meet together at intervals for discussions.

39, 40, 41. SPECIAL WORK

Any Term, 2 to 18 credits

It is desired to give students an opportunity to specialize, as far as the facilities of the School permit, along any line in metallurgy. The work is carried along in each case as the occasion seems to require, in order to give each student the greatest advantage from his work. Elective.

CERAMICS.

PROFESSOR LEIGHTON

The instruction in ceramics is planned so as to give each student a broad engineering training and to furnish him with the fundamental ideas regarding the properties of clays and their methods of manufacture. The course is arranged in such a way that by the proper use of the electives a man may undertake work along various lines, such as pottery and porcelain manufacture, the manufacture of refractories, brick manufacture, etc., although the main object in view will be to turn out men who will be fitted to enter any line of clay mining, clay manufacture, clay investigation or ceramic teaching and prove competent.

I, 2, 3. EXAMINATION AND TESTING OF CLAYS

Fall, Winter, and Spring Terms, 3 credits each term

Includes a study of the origin and properties of clay and a study of the various physical and chemical tests generally applied in investigations.

Prerequisites: Chem. 4, 5, 6; Physics 11, 12, 13.

4, 5, 6. TECHNOLOGY OF CLAYS

Fall, Winter, and Spring Terms, 2 credits each term

The manufacture of clay products.

7, 8, 9. INSPECTION TRIPS

Fall, Winter, and Spring Terms, 1 credit each term

Trips are made to nearby manufacturing plants.

Taken with Cer. 4, 5, 6. (See Insp. 1, 2, 3.)

10, 11, 12. POTTERY AND PORCELAIN

Fall, Winter, and Spring Terms, 2 credits each term

A study of ceramic calculations, glazes, pottery bodies, etc.

Prerequisite: Chem. 12, 13, 14.

13, 14, 15. CERAMIC LABORATORY

Fall, Winter, and Spring Terms, 5 credits each term

Special work on the formation, burning and testing of clays and clay products.

Prerequisite: Cer. 1, 2, 3.

16. ADVANCED CERAMICS

Credits vary

Work in this course can be arranged to meet the desires or need of the student. Primarily for graduate students.

17, 18, 19. SEMINAR

Fall, Winter, and Spring Terms, 1 credit each term

By review of current literature and a study of the important papers previously issued, the student is made familiar with ceramic writing; and the progress of the sciences.

Prerequisite: 1, 2, 3.

20, 21. PLANT DESIGN

Fall and Winter Terms, 3 credits each term

INSPECTION

1, 2, 3.

Fall, Winter, and Spring Terms. 1 credit each term

Visits of inspection are made on alternate Saturdays throughout the School Year to mines, mills, furnaces, oil wells, etc. In each case a written report is required. (Junior Year.) To accompany Mine 1, 2, 3 or 7 and Metallurgy 1, 2, 3.

4, 5, 6.

Fall, Winter, and Spring Terms, 1 credit each term

A continuation of Inspection 1, 2, 3.

This is intended for Seniors, and more complete reports are required.

To accompany Mine 4, 5, 6 or 8, 9, 10.

7.

Spring Term, 6 credits

At the conclusion of the work of the Senior Year a period of three weeks is allowed for a field trip; which will be required of all students

in the Mining, Metallurgical and Geological Groups, except those who, in the opinion of the faculty shall have had a sufficient amount and variety of practical experience to warrant their being excused. No fee is charged for this course.

Three separate trips have been arranged, to alternate.

- (1) Eastern Pennsylvania and New York.
- (2) Michigan iron and copper country.
- (3) Southern coal, iron and copper fields.

The localities visited afford opportunity for advanced work in mining, metallurgy and geology. Special work is assigned to each student, and he is required to keep a careful record of his observations and investigations. At the end of the trip, a complete report, with sketches is required. All work is done under the supervision of instructors from the School.

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UNIVERSITY OF PITTSBURGH

BULLETIN

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ANNOUNCEMENT:—Including the General Catalog and the Announcements of the College, Schools of Engineering, Mines, Economics, Education, Law, Medicine, Dentistry, Pharmacy, Summer Term, Extension.

OFFICIAL:—Including the Chancellor's Report, News Bulletins, Etc.

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For copies of any of the above, address the Secretary, University of Pittsburgh, or the school concerned.

University of Pittsburgh Bulletin

ANNOUNCEMENT SERIES

THE SCHOOL OF MINES

1915-1916



University of Pittsburgh Bulletin

ANNOUNCEMENT SERIES

THE SCHOOL OF MINES

1915-1916



CALENDAR

1915

September 20-25..... Monday to Saturday Registration.
September 27..... Monday, Recitations begin.
November 25-27..... Thanksgiving recess, Thursday to Saturday.
December 18..... First division of semester ends. Vacation of two weeks.

1916

January 3..... Monday—Work resumed.
February 5..... Saturday—First semester ends.
February 7..... Monday—Second semester begins.
February 28..... Monday—Charter Day.
April 15..... Saturday—First division of semester ends. Vacation of one week.
April 24..... Monday—Work resumed.
June 11..... Sunday—Baccalaureate Sermon.
June 14..... Wednesday—Commencement.

OFFICES AND OFFICE HOURS

Office, State Hall, Grant Boulevard—Consultation Hours: 8:30 A. M. to 5:30 P. M.

General Office, State Hall; Telephone Schenley 3300.

For catalogs and other information, address the Secretary of the University, Grant Boulevard.

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LOCATION

STATE HALL, the SCHOOL OF MINES BUILDING, is located at the corner of Grant Boulevard, O'Hara Street and Parkman Boulevard, opposite the Soldiers Memorial, near the Carnegie Institute, including Museum and Library. It is readily accessible from all parts of the City.

SPECIAL ADVANTAGES

The location of Pittsburgh, in the very heart of the bituminous coal fields of the Appalachian system, and in the most richly productive oil fields of Western Pennsylvania, with the great concentration here of mining and metallurgical interests, makes this undoubtedly one of the most advantageous points in the United States in which to study mining and metallurgy.

It is also conveniently located with reference to the bituminous coal fields of Ohio and West Virginia, the anthracite fields of Eastern Pennsylvania, and the Lake Superior iron and copper region.

EQUIPMENT

1. THE MINERALOGICAL AND GEOLOGICAL LABORATORIES are located in the School of Mines. Their equipment is exceptionally complete, the laboratories ranking among the best in the country. Included are:

THE SMITH CABINET. This collection was formed by the two sisters whose name it bears, and is rich in mineralogical and zoological specimens. Especially is it noteworthy for the size and beauty of the objects from the mineral kingdom.

MINERALOGICAL COLLECTIONS. In addition to the Smith collection there is a systematic, labelled collection of 3,500 specimens, numerous smaller sets illustrative of physical properties, crystallization, etc., and large amounts of exceptionally rich material for student use and identification. For crystallography there are large collections of small wooden models, and larger wooden, glass and pasteboard models for lecture use, as well as the latest instruments for crystal measurement.

PETROGRAPHICAL LABORATORY. This contains about 10,000 rock specimens and 5,000 thin sections for microscopic study, 10 petrographic microscopes and a number of the instruments used in more advanced optical mineralogy.

THE GEOLOGICAL LABORATORIES are equipped with numerous collections illustrative of geological phenomena, geologic maps and government reports, collections of fossils, models illustrating structural geology, etc., while through the courtesy of the Director and Trustees of the Carnegie Museum, with part of the staff, opportunity is afforded for the study of the excellent paleontological collections of the Carnegie Museum.

ECONOMIC GEOLOGY LABORATORY. The collection of material illustrative of Economic Geology is proceeding rapidly and includes suites of ores from most of the prominent mining districts, and suites of specimens of the more important non-metallic minerals, such as coals, building stones and clays.

2. THE FIELD-INSTRUMENT EQUIPMENT includes a large assortment of the various types and makes of instruments used in land surveying, railroad surveying, construction work, leveling, geodetic surveying and mine surveying. The instruction of the student in the care, adjustment and use of the various types of instruments has been kept clearly in mind and well provided for in the selection of equipment.

3. THE MINING LABORATORY is equipped with models illustrating the principal systems of mining, hoisting, haulage, etc.; hand drills; breast drills; rock drills; coal-mining machines; miners' lamps (including elec-

tric lamps); apparatus for testing safety lamps; working model of mine fan; instruments for measuring the velocity of air currents, etc.

Steam, air and electricity are directly available as power, there being in the laboratory steam piping, an air compressor and receiver, and a switchboard and complete wiring.

It is planned to reopen and equip completely during the coming year, a mine located on the University Campus, immediately in the rear of the School of Mines Building.

4. THE OIL AND GAS LABORATORY is equipped with apparatus for experimental work in connection with the course in Petroleum Engineering, as well as for original research.

5. GENERAL METALLURGICAL LABORATORY. The work carried on in this laboratory at present includes calorimetry, metallurgical analysis, and electro-metallurgical work, both electrolytic and electrothermic.

The equipment for calorimetry includes one Emerson calorimeter, one Parr calorimeter, and one Junker calorimeter for gas or liquid fuels.

For metallurgical analysis there are the usual chemicals, and glass and porcelain ware, etc., etc. Two fine chemical balances are in an adjoining room; and a large laboratory table is provided for students' use, and contains a number of individual lockers for apparatus. A large hood is provided at one corner of the room for acid evaporations.

Of special analytical apparatus, there is a carbon combustion electric furnace with absorption train. There are two gas analysis sets, an Orsatt and a Morehead burette.

The electro-metallurgical equipment includes a large table with rheostats mounted on the wall behind; a five-cell storage battery for small scale work. There is a good equipment of meters and a potentiometer for the electrical measurements in electrolytical work.

For electric furnace work 220 volt direct current from the University power plant is available thru the control of a nine-unit rheostat of a carrying capacity of about 150 amperes, and a switchboard with 10 double throw switches, giving ample regulation within the capacity of the installation. A 50 k. v. a. set has just been installed under the control of a special transformer, giving a range of voltage of anything from five volts to 240 volts in five-volt steps. There are available one Wile electric furnace, and a tilting basic lined furnace, but it is planned to carry on most of this work in temporary furnaces built up on the concrete floor of the shape and size required by the experiment. With the addition of the transformer set, made by the Pittsburgh Transformer Company for us as a gift, it will be possible to conduct a very large range of experiments in electric furnace construction, operation and processes.

6. METALLOGRAPHY LABORATORY. The equipment for metallography includes one Leitz Micro-metallograph and one Bausch & Lomb metallurgical microscope with camera and arc lamp. For experiments in

heat treatment of small specimens of metals there are several Nichrome-wound electric resistance furnaces; and for heat treatment of larger pieces the coal-fired assay furnaces in an adjoining laboratory are available. For temperature measurements several rare metal thermo couples, with suitable millivoltmeters, are provided; and a potentiometer has just been ordered for more careful work in this line. Besides base metal couples and high temperature thermometers can be used for lower ranges; and for very high ranges of temperature a Fery radiation pyrometer is used for accurate work.

Adjoining the metallography laboratory is a commodious well ventilated photographic dark room. Two Eastman Professional Printers have been installed, to permit finishing of prints in the room at the same time that other students may be developing rapid plates.

The grinding and polishing equipment includes two grinding heads, on which may be mounted eight to ten-inch wheels or discs; a power hack saw; one high speed polishing motor to carry six-inch discs; and a machine carrying two horizontal eight-inch discs for finer polishing.

A considerable collection of samples of metals and alloys has been made and is constantly being enlarged. Also there is a small collection of well-prepared sections to illustrate typical structures and alloys. This collection is being increased rapidly.

7. FURNACE LABORATORY. This laboratory occupies a room 34 feet by 70 feet, lighted both from the side and by sky lights. The furnace equipment includes five two-muffle Denver Fire Clay Company assay furnaces, four of which are coal-fired, and one gas; one coke assay furnace; two American Gas Furnace Company gas muffle furnaces of a large size; one Case self-contained gas furnace. Besides the above larger furnaces there are two small Meeker high temperature gas furnaces and several Fletcher crucible furnaces.

An interesting piece of apparatus is the sintering set, consisting of two pans for different size lots, with a powerful suction fan, ignition being obtained with a gas flame from a Meeker burner.

A number of individual lockers are provided for students in a large, heavy laboratory table. A sufficient number of high grade pulp balances are provided, so that each student may have the use of a balance without delay.

The laboratory is well provided with the smaller accessories such as assay molds, fire utensils, cupel-making machines, etc., etc. Pyrometers are available for special tests.

The electric furnaces are to be placed in this room later, but are at present in the general laboratory.

8. THE ORE DRESSING LABORATORY. This laboratory is designed to illustrate the principles of crushing, screening, classification and concentration of ores, and of allied metallurgical processes, such as amalgama-

tion, cyanidation and leaching. It is the opinion here that these principles can be taught as well by laboratory size apparatus as by the larger apparatus, with a great saving of outlay for original equipment and ores.

The crushing and grinding machinery consists of a Blake crusher, a Case laboratory crusher, three sets of Sturtevant laboratory rolls, Her disk grinder, Abbe pebble mill and McKenna sample grinder.

Sizing and classification apparatus consists of a Sturtevant laboratory shaking screen, a Munroe classifier, and Richard's pulsator classifier.

Concentration machinery consists of a Richard's pulsator jig, a Vezin laboratory jig, a laboratory size Wilfley table, a Munroe slime table, and a testing unit Hyde flotation machine.

Cyanidation and leaching are carried on in a leaching plant capable of handling several hundred pounds.

A Hendryx combined agitator and filter tank for either mechanical or air agitation, as well as a vacuum filter and filter press. A bottle shaking apparatus is provided for bottle tests. Accessory apparatus such as buckboards, screens, sampling riffles and shovels, feeders, etc., are provided.

9. THE CHEMICAL LABORATORIES. These, with the lecture room, occupy the entire third floor of the Engineering Building. Both lecture room and laboratories have been equipped thruout in the most modern manner. Separate laboratories have been installed in the following branches: Introductory Chemistry and Qualitative Analysis; Quantitative Analysis and Food Analysis, with Balance Room in connection; Gas and Fuel Analysis; Water Analysis; Organic Chemistry; Physical and Electro-Chemistry; Spectroscopy; Photography; Micro-Chemistry and Research. On the fourth floor there is a special room for preparation and storage of distilled water, which is delivered by gravity to the various laboratories where it is on tap. A spacious store-room permits the distribution of supplies in such a manner that the requirements of students are promptly met. Machinery for suction and air pressure has been installed and a first-class ventilating system provided so that the air in the laboratories may be pure at all times. The department library is well supplied with works of reference on chemistry for students' use.

10. PHYSICAL LABORATORIES. These are on the first and second floors of the Engineering Building. The lecture room and a large apparatus-room adjoining are on the first floor. The lecture room has a seating capacity of 150, and is provided with all the appliances to facilitate a complete course of experimental lectures.

The general physical laboratory on the second floor is very fully equipped with new apparatus, and is complete in its appointments in every respect. Smaller laboratories are provided for photometry, advanced laboratory practice and research.

A well-equipped shop and mechanic provide excellent facilities for making and repairing apparatus.

The equipment of the department is new and includes an excellent collection of instruments for accurate measurement and investigation.

11. STEAM LABORATORY. There is provided the usual equipment for measuring the pressure, temperature and flow of steam, such as gauges, thermometers, calorimeters, condensers, and indicators, together with suitable apparatus for standardizing and calibrating these.

12. ENGINE AND POWER LABORATORY. The equipment for this department includes the following:

A Babcock & Wilcox, 100 H. P., 200-pound pressure boiler, with a superheating chamber, to be used in experimental and power-plant work.

A composite cross-compound steam engine, $7\frac{1}{2}$ inches and 18 inches by 14 inches, provided with friction-brake, which serves for applying loads. Either side may be operated as a simple engine, condensing or non-condensing.

A two-cylinder Westinghouse gas-engine, and two three-cylinder Westinghouse gas-engines for power purposes.

A motor-driven air-compressor, furnishing air for laboratory needs, and arranged to be used for experimental purposes.

13. MATERIALS TESTING LABORATORY. Equipped with machines and instruments for the measurement of the physical properties of the materials of construction, and for tests on manufactured specimens.

Three Universal testing machines, for tension, compression and flexure tests. The largest, a machine of 200,000 pounds capacity, is capable of taking 15-foot columns, tension specimens accordingly, and flexure specimens up to 20-foot lengths.

Torsion machine, a hand-power machine of 5,000 pounds capacity.

Cement-Testing apparatus, including two automatic briquette-testing machines, standard molds, scales, sieves, moist closet, etc., for the examination of cements, cement-mortars and concrete.

Structural materials testing apparatus, consisting of experimental shearing and punching attachments for testing machines, special extensometers for structural specimens, and a Hanna pneumatic riveter with a capacity of 100,000 pounds die pressure.

14. HYDRAULIC LABORATORY. For hydraulic experiments there are a Worthington two-stage turbine pump, driven by a variable-speed motor, a Pelton wheel, and receiving and measuring tanks with weir discharge. There are also water-meters, orifices, nozzles, a Venturi meter, etc.

15. PRACTICAL MECHANICS LABORATORY. During the coming school year, the School of Engineering will occupy sections of their new shop building, which, when completed, will cover an area 460 feet long and 40

feet wide. The first section to be erected will be devoted to foundry and forge practice.

The equipment will be such as to permit the study of materials and processes of manufacture in such a way as to supplement the students' cooperative work and enhance the value of the practical experience thus obtained.

To permit the study of up-to-date processes of working metals, the forge shop will contain not only representative types of forges and furnaces fired with coke, gas and oil, but drop furnace equipment, together with apparatus and appliances for electric, oxy-acetylene, and thermit molding, brazing, pneumatic riveting, and the cold pressing, punching and drawing of metals.

A special room will be equipped for the more scientific study of the heat treatment of metals and will include barium chloride, lead, tempering and annealing furnaces, pyrometers, and various baths for metals.

The foundry will afford facilities for bench, floor and machine molding, core-making, and the running of heats in irons, brass and aluminum. The equipment will include a standard cupola, special furnaces for iron and brass, core oven, representative molding machines, annealing furnace, tumbling barrel and other foundry appurtenances.

16. ELECTRICAL ENGINEERING LABORATORIES. The machine-laboratory equipment provides for the thorough testing of alternating and direct-current motors by various brake methods, the determination of characteristic curves of generators, synchronous converters, arc lamps, recording meters, storage batteries, etc. The equipment includes a number of generators, motors, etc.

The department switch-board is located in this laboratory and connections can readily be made as desired in any laboratory with the general source of supply or to any machine in the testing laboratory for special work. Power is supplied to the board, both from the Duquesne Light Company and the University Power-Plant, located in the Mechanical Laboratory.

A Westinghouse storage battery of 60 cells, each of 120 ampere-hours capacity, is installed in a separate room. This storage battery, in addition to being used for testing purposes, is also employed for instrument calibration and photometric work.

The photometric equipment is in a special room, and includes all necessary fittings for the work.

In the standard-measurement laboratory, arrangements have been made for work with the potentiometer, calibration of meters, measurements with standard resistances, capacities and inductances or other similar work.

Tests of electrically-operated mining machinery are made in connection with the course in mining.

A small shop has been equipped and put in charge of a competent mechanic, whose time is devoted to the maintenance of the laboratory equipment and the construction of new equipment for special work. This is of great advantage in connection with thesis work or any line of original investigation which it is desired to carry on as it greatly facilitates the erection of special devices which it would otherwise be difficult to secure. Students are also permitted to use the shop in connection with laboratory tests when desirable.

17. PITTSBURGH EXPERIMENT STATION OF THE UNITED STATES BUREAU OF MINES, for the investigation of mine explosions and other factors relating to mining. Its work is available for the students, who are taught there: First Aid to the Injured, and Mine Rescue Work, receiving certificates therefor from the United States Government, and the United States Red Cross Association.

18. THE LIBRARY. The total number of volumes in the University Library is about 10,000. The Reading Room is at present maintained in connection with the Library, and is well supplied with the leading scientific periodicals.

THE CARNEGIE LIBRARY, with its immense collection of scientific books and periodicals, is near the School of Mines Building, and all of the files and collections are available for the use of students.

REQUIREMENTS FOR ADMISSION

All candidates for admission to the School of Mines must be at least seventeen years of age and furnish testimonials of good moral character. Those who come from other institutions must present certificates of honorable dismissal.

METHODS OF ADMISSION

I. CERTIFICATES of the College Entrance Examination Board and of the New York Regents are accepted in lieu of entrance examinations at the University.

For information concerning the dates upon which the examinations of the College Entrance Examination Board are to be held, address The Registrar of the University of Pittsburgh.

II. CERTIFICATES FROM ACCREDITED SCHOOLS. Instead of examination, certificates from high schools and academies whose work has been approved by the University as being equivalent to that required for admission to the Freshman class, will be accepted. The official blank provided by the University should be used. It may be obtained upon application to the Registrar or Dean.

III. FROM OTHER COLLEGES. Students from other institutions having entrance requirements equivalent to those of the University of Pittsburgh and offering equivalent courses of study, will be given provisional credit for the work done and admitted to advanced standing without examination. If their work proves satisfactory, the provisional credits will be made permanent.

IV. SPECIAL STUDENTS. Students showing satisfactory evidence of ability, but who are not candidates for a degree, may be admitted without examination to take any work for which they are prepared. This includes students taking irregular or partial courses owing to lack of time to follow the regular course, as well as persons of age and experience in practical work who wish to take special courses.

EXPLANATION OF REQUIREMENTS FOR ADMISSION.

The University sets no time at which it will offer regular scheduled examinations for admission. This may be arranged if occasion arises. The practical agreement of High School courses in general with the list of subjects allowed for entrance makes such examinations for the most part unnecessary.

For admission to the School of Mines the student who is a candidate for a degree must offer fifteen units, a unit being the equivalent of four recitations per week of one hour each for one year, or five recitations of three-quarters of an hour each.

The units are as follows for 1915:

English, 3 units.

Algebra, $1\frac{1}{2}$ units.

Plane and Solid Geometry, $1\frac{1}{2}$ units.

History, 1 unit.

German, French or Spanish, 2 units.

Physics, 1 unit.

Five additional units must be offered from the approved list, which includes Latin, Greek, Modern Languages, English, History, Civics, Economics, Mathematics, General Science, Physiography, Drawing, Manual Training, Geology, Astronomy, Commercial Geography, Chemistry and Biology. In general, any subject given regularly in an approved high school and properly certified by the Principal will be accepted.

CONDITIONS

No applicant to the Freshman Class with less than twelve units will be admitted as a regular student. It is highly desirable that a student should enter without any conditions, but if they are allowed, they must be removed in part before the Sophomore year, and wholly before the Junior year.

REGISTRATION

The office of the Registrar is in Room 109, State Hall. At this office all registration will be directly made.

All officers of instruction are required to follow the same rules, and under no circumstances to admit to a place upon their rolls the name of any student who has not a card, issued or authorized by the Registrar, in testimony of the fact that he has complied with all regulations, general and specific, both as to his admission and classification, and the payment of tuition or fees.

The office of the University Registrar is open thruout the year. Old students are required to renew their registration before the beginning of every semester, both at the opening of the school year and during the progress of the year.

A penalty of three dollars per semester for late registration may be added to the semester bill. Further information with regard to details may be obtained as required at the office of the Registrar.

ATTENDANCE

Each instructor has charge of absences, conduct and work of the students when in his class. He is required to keep a record of the absences, and to see that work is satisfactorily made up. If these absences are such as seriously to interfere with the progress of the student, the student may be excluded from the examination and required to repeat the work.

The fourth period of the day, beginning at 11:30 A.M. is on Monday Wednesday and Friday, set aside for assemblies of students. The following is the program:

Monday: Meetings of various Student Organizations.

Wednesday: School of Mines Assembly.

Friday: Weekly Convocation. (All Schools.)

Attendance on Wednesday and Friday is obligatory.

SCHOLARSHIPS

A limited number of scholarships are available in the School of Mines. These scholarships entitle the holders to a part or all of the tuition. For a list of these scholarships and information concerning the conditions under which they are awarded apply to the Secretary of the University.

TUITION AND FEES.

(For regular school year — First and Second Semesters)

Tuition \$150.00, payable in two installments, \$80.00 first semester and \$70.00 second semester.

This amount includes all laboratory and shop fees, matriculation fee, student activities fee, and an athletic fee which entitles the student to admission to all University athletic events. There are no other payments to the University except the diploma fee, to be paid on graduation, but each student who takes laboratory courses will be charged for materials which he uses. Registration for each semester must be completed before the day on which the semester opens. A fine of three dollars is charged for registration following that date.

This plan enables the student to know at the beginning of his course exactly what it will cost.

The change from the term to the semester system takes place at the beginning of the school year of 1915—16.

DEGREES

The degrees conferred upon those satisfactorily completing courses are, respectively:

Engineer of Mines (E. M.), Metallurgical Engineer (Met. E.), Geological Engineer (Geol. E.), Petroleum Engineer (Pet. E.).

THESIS

A thesis is required of every candidate for degree. The thesis subject, together with an outline of the work proposed, must be approved by the head of the department in which the student is classified, not later than January 15th preceding commencement; and when so approved will be assigned to him on a blank furnished for the purpose. A memorandum of this assignment must be filed in the office of the Dean.

The thesis in the proposed final form must be submitted to the Professor in charge at least two weeks prior to commencement, and must be in the hands of the Dean before Commencement Day.

The results obtained and the thesis prepared in connection with a regularly assigned thesis subject are the property of the University and no part of the thesis may be published without the consent of the Chancellor.

COURSES IN THE SCHOOL OF MINES.

UNDERGRADUATE

In order to retain the advantages of the elective system, whereby the student is permitted to choose his work along the line for which he seems best fitted, and at the same time to be certain that every man shall have a well-rounded course, the following group system is in effect:

The first two years' work is common to all courses. At the beginning of the third year, the student elects between Mining, Metallurgy, Ore Dressing, Geology and Oil and Gas Production, with a further choice (in Mining) between general mining and coal-mining, with special attention to either the engineering or the business side, according to the option; and in Metallurgy, between general metallurgy and the metallurgy of iron and steel.

COOPERATIVE WORK

During the summer vacations the student is expected to spend his time in practical work in mine, mill or smelter, or in the field; he is here placed upon the same basis as other employees of the company to which he is assigned, and receives the same pay as others doing the same grade of work. The superintendent advises the Dean monthly as to the progress made, and at the close of the summer period the student makes a written report, which is graded in the same way as is class work. Upon graduation, then, he will have had the advantage of at least ten months practical work in his chosen field. An important feature of the work of the School of Mines is this linking of theory with practice and it is all important to the student in his preparation for his profession.

The positions to which students are assigned cover all phases of the work in mining, metallurgy, geology and oil and gas production. In addition to the Pittsburgh district, students have been placed in Arizona, Colorado, Idaho, Michigan, Minnesota, Montana, Missouri, New Mexico, South Dakota, Ontario, etc. for the summer 1915.

GRADUATE

For graduate courses in the School of Mines, see the bulletin of the Graduate School.

The aim is to offer such advanced work in Economic Geology, Mining, Oil and Gas, Metallurgy and Ore Dressing, as will meet the needs of men having at least one year of practical work following graduation from a recognized mining school.

In addition to the subjects mentioned above, certain courses in Economics, Sociology and Psychology, etc., have been arranged with special reference to their application to mining and metallurgy, with the idea of training men along managerial lines.

Each application for admission will be decided upon its own merits. In general, however, graduation from a recognized technical school, supplemented by at least one year's practical work, will be necessary for admission.

EVENING COURSES

Short courses in mining, general metallurgy, the metallurgy of iron and steel, metallography, and oil and gas production, are offered each year.

EXTENSION DEPARTMENT

Short courses have been arranged primarily for practical mining men, but open to all interested persons. The subjects covered are such as to prepare candidates for the state examinations for certificates of qualification as Fire Boss, Mine Foreman or Mine Inspector. Outlines of the several courses will be found on page 21. On satisfactory completion of any of these, a certificate of proficiency will be given.

Each class meets once a week in the evening, courses beginning about October 1st, and closing about May 1st. Classes are organized on application at places convenient to the students, and are conducted by special instructors from the School of Mines.

OUTLINE OF COURSES.

GROUP I. Leads to degree of Engineer of Mines.

(a) General Mining.

Mechanical-Electrical option.

Management option.

(b) Coal Mining.

Mechanical-Electrical option.

Management option.

GROUP II. Metallurgy. Leads to degrees of Metallurgical Engineer.

(a) General Metallurgy.

(b) Metallurgy of Iron and Steel.

(c) Ore Dressing.

GROUP III. Geology. Leads to degree of Geological Engineer.

GROUP IV. Oil and Gas Production. Leads to degree of Petroleum Engineer.

FRESHMAN AND SOPHOMORE YEAR

REQUIRED IN ALL GROUPS

FRESHMAN YEAR.

SUBJECT	See Page	FIRST SEMESTER			SECOND SEMESTER		
		No.	Hours		No.	Hours	
			Class	Lab.		Class	Lab.
Mathematics		2	3	.....	11	2	.....
Mathematics		3	2	.....	13	3	.....
Chemistry		1	2	6	2	2	6
Graphics		11, 13	1	6	12, 14	1	6
English		3	3	.....	4	3	.....
German, French or Spanish		1	3	.....	2	3	.....
Physical Education		1	.....	3	2	.....	3

SOPHOMORE YEAR

SUBJECT	See Page	FIRST SEMESTER			SECOND SEMESTER		
		No.	Hours		No.	Hours	
			Class	Lab.		Class	Lab.
Mathematics		12	2	.....	.....	.....	.....
Mathematics		14	3	.....	.....	.....	.....
Mechanics					1	4	.....
Chemistry		21	2	6	22	2	6
Physics		11	4	3	12	4	3
Geology		1	3	.....	2	3	.....
Mineralogy		1	2	6	2	2	6
Physical Education		3	.....	3	4	.....	3

GROUP IV.						
Petroleum Engineering						
Geological Option				Operating Option		
	No.	Hours		No.	Hours	
		Class	Lab.		Class	Lab.
(to	1	5	45	1	5	45
(Jan. 3	2	5	0	2	5	0
	3	0	3	3	0	3
	.....	.....	.....	2	3	3
	3e	3	0	3e	3	0
	3	2	3	3	2	3
						
						
						
						
						

JUNIOR YEAR

			GROUP I									GROUP II.									GROUP III.			GROUP IV.									
			Mining Engineering						Metallurgical Engineering									Geological Engineering			Petroleum Engineering												
			Mechanical-Electrical Option			Management Option			General Met. Option			Iron and Steel Option			Ore Dressing Option						Geological Option			Operating Option									
Period	SUBJECT	See Page	No.	Hours		No.	Hours		No.	Hours		No.	Hours		No.	Hours		No.	Hours		No.	Hours		No.	Hours		No.	Hours		No.	Hours		
				Class	Lab.		Class	Lab.		Class	Lab.		Class	Lab.		Class	Lab.		Class	Lab.		Class	Lab.		Class	Lab.		Class	Lab.		Class	Lab.	Class
First (to Dec. 18)	M. Surveying		1	5	45	1	5	45	1	5	45	1	5	45	1	5	45	1	5	45	1	5	45	1	5	45	1	5	45	1	5	45	
Second (Jan. 3—Mar. 18)	Mechanics		2	5	0	2	5	0	2	5	0	2	5	0	2	5	0	2	5	0	2	5	0	2	5	0	2	5	0	2	5	0	
	Mechanics		3	0	3	3	0	3	3	0	3	3	0	3	3	0	3	3	0	3	3	0	3	3	0	3	3	0	3	3	0	3	
	Elec. Engineering		2	2	3	2	2	3	2	2	3	2	2	3	2	2	3	2	2	3	2	2	3	2	2	3	2	2	3	2	2	3	
	Economics		3e	3	0	3e	3	0	3e	3	0	3e	3	0	3e	3	0	3e	3	0	3e	3	0	3e	3	0	3e	3	0	3e	3	0	3e
	Geology																																
	Mineralogy																																
	Econ. Geology		1	4	0	1	4	0																									
	M. Surveying		3	0	3	3	0	3																									
	Mining		3 or 7	3	0	3 or 7	3	0																									
	Metallurgy									3	3	6	3	3	6	3	3	6															
	Metallurgy												5	4	6																		
	Ore Dressing									3	4	0							3	4	0												
	Petroleum																																
	Petroleum																		1	4	0												
	Petroleum																																
	Inspection			1			(Alternate Mondays thruout the period)																										
Third (Mar. 20—June 14)	Civil Engineering		23	2	6																												
	Mech. Engineering		4	2	3	4	2	3	4	2	3	4	2	3	4	2	3	4	2	3	4	2	3	4	2	3	4	2	3	4	2	3	
	San. Engineering		1	5	0	1	5	0	1	5	0	1	5	0	1	5	0	1	5	0	1	5	0	1	5	0	1	5	0	1	5	0	1
	San. Engineering		2	0	3	2	0	3	2	0	3	2	0	3	2	0	3	2	0	3	2	0	3	2	0	3	2	0	3	2	0	3	2
	Economics					19	3	0																									
	Geology																																
	Mineralogy																																
	Econ. Geology		2	4	0	2	4	0																									
	M. Surveying		4	0	3	4	0	3																									
	Mining		4 or 8	3	0	4 or 8	3	0																									
	Metallurgy									4	3	6	4	3	6	4	3	6	4	3	6												
	Metallurgy												6	4	6																		
	Ore Dressing									4	4	6							4	4	6												
	Petroleum																																
	Petroleum																		2	4	0												
	Petroleum																																
Petroleum																																	
Inspection			2			(Alternate Mondays thruout the period)																											

Semester	SENIOR YEAR																																		
First	Mechanics	4	1	6	4	1	6	4	1	6	4	1	6	4	1	6																			
	Chemistry								111	2	0	111	2	0							29	1	6	29	1	6									
	Chemistry																			31	2	6	31	2	6										
	Chemistry																			41	2	3	41	2	3										
	Biology																			1	1	6													
	Paleontology																			1	2	6	1	2	6										
	Economics				13	2	0																			21	2	0							
	Economics				21	2	0																			47	2	0							
	Econ. Geology																			3	2	0													
	Econ. Geology																			5	1	0													
	Elec. Engineering	27	2	3																															
	Mining	5 or 9	3	0	5 or 9	3	0		1	3	0	1	3	0	1	3	0				1	3	0												
	Mining	11	2	3	15	3	0																												
	Mining	17	2	0	17	2	0														17	2	0												
	Metallurgy	1	2	6	1	2	6														1	2	6												
	Metallurgy								9	3	0	9	3	0	9	3	0																		
	Metallurgy								11	4	6	11	4	6	11	4	6																		
	Metallurgy								13	2	6	13	2	6	13	2	6				5	4	12	1	2	0									
	Ore Dressing	1	2	0	1	2	0																												
	Petroleum																									5	2	0		5	2	0			
Petroleum																																			
Petroleum																																			
Inspection		3			3				3				3					3				3				3				3					
Second	Chemistry								112	2	0	112	2	0							42	2	3	42	2	3	42	2	3	42	2	3	42	2	3
	Biology																			2	1	6	178	2	0	178	2	0							
	Paleontology																			2	2	6	2	2	6										
	Economics				16	2	0																			22	2	0							
	Economics				22	2	0																			39	2	0		39	2	0			
	Economics	46	2	0	46	2	0		46	2	0	46	2	0	46	2	0																		
	Economics																																		
	Econ. Geology																			4	2	0													
	Econ. Geology																			6	1	0													
	Elec. Engineering	28	2	3																															
	Mining	6 or 10	3	0	6 or 10	3	0																												
	Mining	12	2	3																															
	Mining	14	0	6	14	0	6																												
	Mining																																		
	Mining	18	0	3*	18	0	3*																												
	Metallurgy	2	2	3*	2	2	3*																												
	Metallurgy								10	2	0	10	2	0	10	2	0																		
	Metallurgy								12	4	6	12	4	6	12	4	6																		
	Metallurgy								14	2	6	14	2	6	14	2	6																		
	Metallurgy								16	2	6	16	2	6	16	2	6																		
Ore Dressing		2	2	3	2	2	3												6	2	12	2	2	3											
Petroleum																									6	2	0		6	2	0				
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Inspection		4			4				4				4					4				4				4				4					

EXTENSION COURSES.

1. Mine Gases. This course is adapted to the needs of candidates for Fire Boss.

Chemistry of Gases.
Mine Gases and Mixtures.
Mine Explosions.
Safety Lamps.
Elementary Mine Ventilation.
Mining Law for the Fire Boss.
Mine Safety.

2. Principles of Coal Mining. This course is adapted to the needs of candidates for Mine Foreman.

Mine Ventilation (continued).
Methods of Coal Mining.
Timbering.
Haulage.
Hoisting.
Drainage and Pumping.
Mining Law for the Foreman.
Mine Safety.
Must be preceded by Course 1, or its equivalent.

3. Advanced Coal Mining. This course is adapted to the needs of candidates for Mine Inspector.

Trigonometry and Surveying.
Geology of Coal.
Steam Engines and Boilers.
Compressed Air.
Elementary Electricity.
Coal Mining Economics.

In addition to the above, the subjects in Courses 1 and 2 are continued. Must be preceded by Courses 1 and 2 or their equivalent.

4. Electricity. This course is intended to cover the subjects needed by a mine electrician.

Principles of Electricity.
Electrical Mine Machinery.
Steam Engines and Boilers.
Mine Gases.
Elementary Mine Ventilation.
Mining Law relating to electricity.
Mine Safety.

DEPARTMENTS OF INSTRUCTION

The following include the required courses in the School of Mines, together with a few electives which it was thought might be chosen by students of the School. For further studies which are open as electives, see the general catalog of the University.

ENGLISH

3, 4.

Mr. Bothwell.

A course designed particularly for prospective mining engineers, comprising detailed study of:

(1), the formal mechanics of writing: viz., Punctuation, syllabication, hyphenation, abbreviations, representation of numbers, capitalization, legibility, and arrangement of manuscript;

(2), diction, faulty expressions, spelling, and words commonly mispronounced;

(3), rules of sentence, paragraph, and thematic structure, together with the principles of rhetoric as applied especially to the following forms of technical exposition: viz., business and social letters, reports, abstracts, lecture and classroom notes, outlines (analytic and synthetic), and articles for technical journals;

(4), oral reports and public speaking;

(5), the use of a reference library, and collateral reading from technical journals;

(6), the profession of engineer,—its dignity, its scope, and the requisites for its successful practice.

Texts: Woolley's *Handbook of Composition*, Slater's *Freshman Rhetoric*, Sypherd's *Handbook of English for Engineers*, Waddell and Harrington's *Addresses to Engineering Students*.

Three recitations a week, First and Second Semesters, Freshman year.

GERMAN LANGUAGE AND LITERATURE

PROFESSORS RASCHEN AND BERGER, AND MESSRS. ARTHUR AND KLEIN

I, 2. ELEMENTARY GERMAN

PROFESSORS RASCHEN AND BERGER AND MESSRS. ARTHUR AND KLEIN

A continuous course for students in the essentials of German. The formal study of grammar subordinated to the direct method of acquiring

command of the spoken and written idiom. German is the chief medium of instruction. Mastery of phonetic principles. Reading of easy prose works. Reproduction of text in German. Systematic acquisition of vocabulary. Learning of folksongs. Retroversion. Writing German. Inductive study of grammatical forms.

Three recitations per week.

First and Second Semesters

3, 4. INTERMEDIATE GERMAN

PROFESSORS BERGER AND MESSRS. ARTHUR AND KLEIN

Reading of modern narrative and descriptive prose. Reproduction of text in German. Simple composition. Summarization of principles of grammar.

Three recitations per week.

First and Second Semesters

Prerequisite, Courses 1, 2, or two years of High School German.

T. 3, T. 4. TECHNICAL GERMAN.

MR. KLEIN

Rapid review of grammar. Reading of texts on technical subjects. Reading from German scientific journals. Collateral reading.

Three recitations per week.

First and Second Semesters

Prerequisite, Courses 1, 2, or two years of High School German.

ROMANCE LANGUAGES AND LITERATURE

PROFESSOR FARNSWORTH, DR. BOYCE, MESSRS. SHELTON, MCKEE, FLAMBARD

French

1, 2. ELEMENTARY FRENCH

MR. SHELTON

Fraser and Squair's Shorter French Course. Composition and easy reading, with thoro drill in pronunciation and practice in speaking.

Three recitations per week.

First and Second Semesters

3, 4. INTERMEDIATE FRENCH

DR. FARNSWORTH AND MR. SHELTON

Fraser and Squair's Grammar completed. Selections from representative authors will be read. Exercises in French conversation.

Three recitations per week.

First and Second Semesters

T. 3, T. 4. TECHNICAL FRENCH

MR. SHELTON

The purpose of this course is to enable students to use Scientific French readily. The work is based on texts on technical subjects, with reading from French scientific journals.

Three recitations per week.

First and Second Semesters

Spanish

I, 2. ELEMENTARY SPANISH

DR. BOYCE

A thoro study is made of the elements of the language, with constant practice in oral work.

Three recitations per week.

First and Second Semesters

C. 3, C. 4. COMMERCIAL SPANISH

DR. BOYCE

Reading of Commercial Spanish. Business correspondence. Conversation. The vocabulary of everyday life is emphasized.

Three recitations per week.

First and Second Semesters

Italian

I, 2. ELEMENTARY ITALIAN

DR. FARNSWORTH

The instruction is practical and consists of a thoro drill in the elements of the grammar and in pronunciation. Translation, dictation, conversation and easy composition.

Three recitations per week.

First and Second Semesters

3, 4. ITALIAN, INTERMEDIATE COURSE

DR. FARNSWORTH

Italian literature of the XVIII and XIX centuries. Selected readings and brief lectures in Italian. Conversation and composition.

Open to students who have taken the course in Elementary Italian.

Three recitations per week.

First and Second Semesters

MATHEMATICS.

MR. FORAKER, MR. MORRISON.

2. PLANE AND SPHERICAL TRIGONOMETRY.

MR. FORAKER.

Goniometry, logarithms, solution of right and oblique triangles and applications, inverse functions, trigonometric equations, complex numbers
Three recitations per week.

First Semester, Freshman Year.

3. ALGEBRA (Short course.)

MR. FORAKER.

Theory of quadratics with graphical representations, mathematical induction, variation, progressions, theory of equations, limits, infinite series undetermined coefficients, determinants.

Two recitations per week.

First Semester, Freshman Year.

II. ANALYTIC GEOMETRY (Part I.)

MR. MORRISON.

Coordinates, graphs, transformation of coordinates, straight line, circle.

Two recitations per week.

Prerequisites: 2, 3.

Second Semester, Freshman Year.

12. ANALYTIC GEOMETRY (Part II.)

MR. MORRISON.

A continuation of Course 11. Conic sections, general equation of the second degree, higher plane curves.

Two recitations per week.

Prerequisite: 11.

First Semester, Sophomore Year.

13. DIFFERENTIAL CALCULUS.

MR. MORRISON.

Differentiation, successive differentiation, maxima and minima, partial derivatives, applications of the derivative to geometry, physics and mechanics.

Three recitations per week.

Prerequisites: 11, or in conjunction with it.

Second Semester, Freshman Year.

14. INTEGRAL CALCULUS.

MR. MORRISON.

Different methods of integration, definite integrals, multiple integrals, applications of integration to geometry and mechanics.

Three recitations per week.

Prerequisites: 13; and also 12, or in conjunction with 12.

First Semester, Sophomore Year.

CHEMISTRY

PROFESSOR SILVERMAN AND ASSISTANTS

I, 2. GENERAL INORGANIC CHEMISTRY

PROFESSOR SILVERMAN AND MESSRS. ROBERTS, CLEGG, RAMSEY, ASHE, BALANTYNE, HUMPHREY, SHUMAKER, DUNPHY AND MORTON

A study of the metals and non-metals, principles, theories and calculations. This course is intended for mining students who have not had chemistry in preparatory schools. Visits are made to a considerable number of manufacturing establishments so that the student may see practical applications of chemical principles. Two lectures and two three-hour laboratory periods per week. A recitation is conducted at the beginning of each laboratory period.

First and Second Semesters, Freshman Year.

III, II2. ADVANCED INORGANIC CHEMISTRY

PROFESSOR GARNER

This course supplements the work in courses 1, 2, 3, which are pre-requisite. It deals especially with modern chemical theory.

Two lectures per week. Required in Group II.

First and Second Semesters

21, 22. QUALITATIVE AND QUANTITATIVE ANALYSIS

DR. NEIDLE, AND PROFESSORS ELLEDGE, HOLDEN, PERKINS, AND MR. ESSEX

A study of the qualitative tests applied in detection of the more common elements and compounds followed by methods for separation of the various elements from each other. On completion of this work, the student is given instruction and practice in the exact or quantitative determination of some of the above elements by both gravimetric and volumetric methods. Modern ideas in inorganic and physical chemistry are applied. One lecture, one recitation and two three-hour laboratory periods per week.

First and Second Semesters, Sophomore Year

29. GAS ANALYSIS AND CALORIMETRY.

PROFESSOR PHILLIPS

This course includes the qualitative examination of gases and the more important methods for qualitative analysis of air, natural gas, artificial gases and flue gas. The second period is devoted mainly to the experimental determination of the calorific values of solid, liquid and gaseous fuels, with practice in the use of various fuel calorimeters.

One lecture and two three-hour laboratory periods, First Semester, Senior Year, Group IV.

Prerequisites: 21, 22.

31, 32. ORGANIC CHEMISTRY

PROFESSORS PRATT, BISHOP, CLAYTON, KOHMAN, PADGETT, ROSE AND MR. VAWTER

An introduction to the chemistry of the compounds of carbon. The student is given an opportunity to prepare a large number of typical carbon compounds and study their properties, reactions, and uses.

Two lectures and two three-hour laboratory periods per week.

Prerequisites: 1, 2, 21, 22. Required in Group IV.

First and Second Semesters

41, 42. PHYSICAL CHEMISTRY.

DR. NEIDLE.

A study of the laws governing chemical phenomena. The Spring months are devoted to a consideration of the theoretical principles and some practical applications of electro-chemistry.

Two lectures and one three-hour laboratory period, First and Second Semesters, Senior Year, Group IV.

Prerequisites: 21, 22, and Math. 2, 3, 11, 12, 13, 14.

123. ADVANCED QUALITATIVE ANALYSIS

DR. NEIDLE

The physico-chemical basis of analytical chemistry is emphasized, and the laboratory work includes qualitative analyses of alloys, ores, paints, etc.

One lecture, one recitation and two three-hour laboratory periods per week.

Prerequisite: 21, 22.

First and Second Semesters

124. ADVANCED QUANTITATIVE ANALYSIS

DR. NEIDLE

The methods introduced in the elementary course are employed in complete quantitative analyses of ores, alloys and commercial products.

One lecture, one recitation and two three-hour laboratory periods per week.

Prerequisite: 21, 22.

Second Semester

178. PETROLEUM

PROFESSOR BROOKS

A two-hour lecture course given in the School of Mines on the chemistry, distillation and refining of petroleum.

Second Semester, Senior Year, Group IV

PHYSICS

PROFESSOR BISHOP AND MR. ULREY.

11, 12. GENERAL PHYSICS

First term, mechanics and heat; second term, electricity; third term, sound and light. In this course the calculus is extensively employed and special attention is given to the physical interpretation of mathematical equations.

A series of twelve lectures on the precision of measurements is given in connection with the laboratory work. Special attention is given in the laboratory to the method of the experiment and to the precision of the results.

Concurrent with Mathematics 14.

Four lectures or recitations and one three-hour laboratory period per week.

First and Second Semesters, Sophomore Year

GRAPHICS

MR. CHAMBERLIN

11. MECHANICAL DRAWING

A thoro course in engineering lettering and title framing, followed by the study of isometric projection. Special emphasis is laid on the application of oblique projection to technical sketching.

Three hours per week in drafting room.

First Semester, Freshman Year

12. MECHANICAL DRAWING

Graded exercises in the detail drafting of mechanical constructions, in which special attention is given to the selection and grouping of the views of the various parts. A careful study of the application of the principles of third-quadrant orthographic projection to the requirements of drafting practice. The extensive use of models serves to familiarize the student with actual working conditions.

Three hours per week in drafting room.

Second Semester, Freshman Year

13. MECHANICAL DRAWING AND DESCRIPTIVE GEOMETRY

The object of this course is to combine the study of mechanical drawing with that of descriptive geometry in such a way as to early make

clear the space relationships of points, lines, and planes, at the same time that orthographic projection is being studied in detail.

One lecture and three hours per week in drafting room.

First Semester, Freshman Year

14. DESCRIPTIVE GEOMETRY

A critical study of curved lines and surfaces, with their relations to each other; tangent lines and planes; intersection of surfaces; shades, shadows, and perspective. Special attention is devoted to the development of surfaces as applied to sheet metal drafting.

One lecture and three hours per week in drafting room.

Second Semester, Freshman Year

MECHANICS

PROFESSORS WEBBER, LAMBIE AND WEBER

1. ANALYTIC MECHANICS

PROFESSOR WEBBER

This subject comprises among its topics the composition and resolution of forces, the center of gravity, the moment of inertia, radius of gyration, laws of friction and of motion, projectiles, impact, machines, work, and energy. The solution of numerous problems in application of formulas is constantly required.

Four recitations and lectures per week.

Second Semester, Sophomore Year

2. MECHANICS OF MATERIALS

PROFESSOR LAMBIE

The resistance and elasticity of materials. The action of beams under various conditions of fixity and loading; strength of columns and shafts; combined stresses; resilience of materials, etc.

Five recitations and lectures per week.

Second Period, Junior Year

3. MECHANICAL LABORATORY

PROFESSOR WEBER

The experimental study of the physical properties of the materials of construction, such as iron and steel, wood, brick, stone, cement, and concrete.

Three laboratory hours per week.

To be taken concurrently with Mechanics 2.

Second Period, Junior Year

4. GRAPHIC STATICS

PROFESSOR LAMBIE

The solution of problems in which the stresses in frame work, beams, roof and bridge trusses are ascertained by graphical methods. Methods for dead, snow, wind and live loads.

One lecture and six hours' drawing per week.

Prerequisites: Graphics 3a; Mechanics 1.

First Semester, Senior Year

CIVIL ENGINEERING

PROFESSOR LAMBIE

23. ELEMENTS OF MASONRY AND CONCRETE CONSTRUCTION

This is a short course, designed to meet the needs of mining engineers. It comprises a brief outline of the theory, and a study of practical construction of reinforced concrete beams and slabs, masonry and concrete foundations, retaining walls and arches. The laboratory exercises include the testing of cements, sand, gravel, mortar and concrete specimens.

Two lectures and six laboratory hours per week. Required in Group I, Mechanical Option.

Third Period, Junior Year

MECHANICAL ENGINEERING

PROFESSOR WEBER AND MR. WIGLEY

(1a). ELEMENTARY MECHANICAL LABORATORY

MR. WIGLEY

The elementary study of casting design from the standpoint of moulding and founding. The student is required to mould a graded set of patterns, run off heats, and cast a number of representative test specimens from various metals. The lecture and recitation work covers the study of the properties of castings and the production of same on a commercial scale. Inspection trips are made to local foundries.

One lecture or recitation and three hours elementary laboratory work per week.

(2a). ELEMENTARY MECHANICAL LABORATORY

MR. WIGLEY

The elementary study of the treatment and properties of wrought iron, soft steel and carbon tool steel. The student is required to forge and machine a number of representative test specimens which will bring out the characteristics and strength of materials. The lecture and recitation

work covers the study of the properties of wrought metals, and the working and forging of same on a commercial scale. Inspection trips are taken to local industrial plants.

One lecture or recitation and three hours elementary laboratory work per week.

(3a.) ELEMENTARY MECHANICAL LABORATORY

MR. WIGLEY

Machine elements and structural details are prepared and tested, and the results reported. The lecture and recitation work includes the discussion of the results of laboratory tests and the study of the elementary features of machine and structural design.

One lecture or recitation and three hours elementary laboratory work per week.

4. PRIME MOVERS

PROFESSOR WEBER

A brief study of the construction and operation of steam boilers, engines and turbines; and of gas engines and producers.

Two lectures and three laboratory hours per week.

Prerequisites: Mechanics I; Physics 12.

Third Period, Junior Year, Groups I, II and IV

ELECTRICAL ENGINEERING

PROFESSOR DYCHE AND MR. POWERS

2. APPLIED ELECTRICITY

PROFESSOR DYCHE AND MR. POWERS

This is a short course designed to meet the requirements of those not specializing in Electrical Engineering.

Two lectures and recitations and three hours laboratory per week.

Prerequisite: Physics 12.

Second Period, Junior Year, Groups I, II and IV

27, 28.

PROFESSOR DYCHE

A course covering mining machinery operated by electric power, as well as other uses of electricity in connection with mining.

The power plant; transmission of electricity; haulage; hoisting; pumping; air compression; rock drilling; coal cutting; ventilation; signalling; lighting.

Two lectures or recitations and one three-hour laboratory period per week.

First and Second Semesters, Senior Year, Group I (Mechanical Option).

SANITARY ENGINEERING

PROFESSOR CASE

1. HYDRAULICS

The equilibrium and pressure of liquids; the motion and work of fluids; the flow of water through orifices, over weirs, in pipes, and in canals; measurement of water power; and hydraulic machinery.

Five recitations and lectures per week.

Third Period, Junior Year

2. HYDRAULIC LABORATORY

The experimental study of the flow of water through pipes, nozzles, orifices, over weirs and in streams. Capacity and efficiency tests of hydraulic turbine pumps and motors.

Three laboratory hours per week.

Taken concurrently with S. E. 1.

Third Period, Junior Year

ECONOMICS

PROFESSORS HOLDSWORTH AND MESSRS. DAVISON AND WRIGHT
WRIGHT.

3 E. ECONOMICS

MR. DAVISON

A brief resume of fundamental economic theory; application to practical economic questions; wages, interest, rent, management, credit, banking, taxation, trusts, tariff, trade, social reform. Text-book and lectures.

Three lectures or recitations per week.

Second Period, Junior Year

13. MODERN INDUSTRIES

MR. DAVISON

A study of the leading manufacturing industries including sources, supply and marketing of minerals and other raw materials; factors affecting the location of industry and cost of production; domestic and foreign trade.

Two lectures or recitations per week, with assigned readings and reports. First Semester, Senior Year, Group I (Management option)

16. INDUSTRIAL MANAGEMENT

MR. DAVISON

Advantages of different types of business organizations; principles of business management; factory and plant efficiency; profit-sharing; labor problems; efficiency standards and methods.

Two lectures or recitations per week, with assigned readings and reports.

Second Semester, Senior Year, Group I (Management option)

19. LABOR PROBLEMS

MR. DAVISON

Evolution of the labor problem; organization and methods of trade unions and employers' associations; open versus closed shop; strikes and lockouts; wage systems; "safety first"; immigration; employers' liability; arbitration and conciliation.

Three lectures or recitations per week, with assigned readings and reports.

Third Period, Junior Year, Group I (Management option), Group IV (Operating Option).

21, 22. CORPORATION FINANCE AND INVESTMENTS

PROFESSOR HOLDSWORTH

Legal and financial organization of corporations; classes and characteristics of stocks and bonds; sources of capital; the promoter and underwriting; disposition of earnings; legal and commission control; receiverships and reorganizations; analysis of typical investments.

Two lectures or recitations per week, with assigned readings and reports.

First and Second Semesters, Senior Year, Group I (Management option), Group IV (Operating Option).

46. CONTRACTS AND SPECIFICATIONS

MR. WRIGHT

The fundamental principles of contracts, their formation, operation and termination; principal and agent; partnerships and corporations; exercises in the drafting of contracts and specifications peculiar to the mining and engineering business.

Two hours per week.

Second Semester, Senior Year, Groups I, II and IV (Operating option).

49b. MINE ACCOUNTING

PROFESSOR FLOCKEN

The principles of general accounting and their application to the recording, classifying and summarizing of mining transactions; the application of cost accounting principles to mining labor, supplies, and overhead, revenue and financial statements; accounting for subsidiary enterprises connected with mining companies.

Two hours per week.

Second Semester, Senior Year

39. STATISTICS

PROFESSOR FLOCKEN

This course is intended to present the methods of determining, analyzing, and interpreting social and economic facts by the use of statistics. It includes a consideration of the following: sources of statistics; collection of data; analysis and interpretation of data by the use of averages, diagrams, tables and frequency curves; accuracy; variation and correlation; development of statistics; and a consideration of the value of various statistical undertakings. The method is illustrated by its application to reliable data in the field of business and in the social sciences.

Text-books, lectures, and assigned readings.

Two hours per week.

Second Semester, Senior Year, Group IV

SOCIOLOGY

1, 2. THEORY OF SOCIOLOGY

PROFESSOR TODD

This course includes a study of the development of sociology, its importance and place in the social sciences, and of the underlying biological, physical and psychical factors in sociology.

Two recitations per week.

First and Second Semesters.

PSYCHOLOGY

PROFESSOR WHITE AND DR. SNYDER

4. GENERAL PSYCHOLOGY FOR TECHNICAL STUDENTS

DR. SNYDER

This is an introduction to the study of human nature and the psychological forces behind material progress. Emphasis will be placed upon such problems as individual differences of character and intelligence, their

causes and significance; the fundamental instincts, imitation, competition, co-operation; the many social relationships, suggestion, habit, memory, constructive imagination, the emotions, reason, will, etc.

Four recitations per week.

Second Period

MINERALOGY AND PETROGRAPHY

PROFESSOR LEIGHTON

1, 2. GENERAL MINERALOGY

Includes the subjects of crystallography, mineralogy and lithology. Required of all students in the School of Mines and open to any qualified student who desires a comprehensive knowledge of the subject. About 250 mineral species are studied and stress laid on the actual determination of unlabelled material.

Two lectures or recitations and two three-hour laboratory periods per week.

First and Second Semesters, Sophomore Year

4. MATHEMATICAL CRYSTALLOGRAPHY

The calculation of axial ratios and other constants in crystals and the methods of projecting and drawing crystals.

Second Semester

105, 106. ADVANCED MINERALOGY.

Advanced or research work in crystallography, mineralogy or lithology. Primarily for graduate students, but open to all having sufficient training.

Courses to suit the needs of the student.

7, 8. PETROGRAPHY

Includes a study of optical crystallography, the optical determination of minerals, and the determination and classification of rocks by microscopic methods.

One lecture or recitation and two three-hour laboratory periods per week.

Second and Third Periods, Junior Year, Group III

109, 110. ADVANCED PETROGRAPHY

Courses to suit the needs of the student.

GEOLOGY

PROFESSOR JOHNSON

1, 2. INTRODUCTORY GEOLOGY

The probable origin of the earth, volcanic and earthquake activities, destructive and constructive work of air and water, etc.

The ancient life history of the earth. The successive continent outlines with the plant and animal life characteristic of the times. The general areal geology of North America. The geological distribution of economic minerals. Interpretation of the geologic significance of earth features and structure.

Three lectures, recitations or exercises per week, with additional field work.

First and Second Semesters, Sophomore Year

3. GEOLOGICAL METHODS

A training course for men who intend to do original work in geology. For graduates and undergraduates.

Two lectures or recitations and one laboratory period per week.

Second Period, Junior Year, Groups III and IV

4. THE GEOLOGY OF NORTH AMERICA

For graduates and undergraduates.

Two lectures or recitations and one laboratory period per week.

Third Period, Junior Year, Groups II and IV

5, 6. SEMINAR IN GEOLOGY.

PROFESSOR JOHNSTON.

A seminar for the study of current development and progress. The current periodicals and reports are reviewed.

One hour per week.

First and Second Semesters.

107, 108. GEOLOGICAL LABORATORY

Work upon a series of problems adapted to the needs of the particular student, or research in one problem. For graduates and undergraduates.

First and Second Semesters

PALEONTOLOGY

PROFESSOR ORTMAN

1, 2. GENERAL PALEONTOLOGY

This course is intended to present a general survey of the field of Invertebrate Paleontology. The work will consist of lectures and laboratory work, for which latter the rich resources of the Carnegie Museum provide splendid facilities. The ancient life history of the earth will be treated in broad outlines and the structure of the leading groups of fossil organisms elucidated with a view toward illustrating their lines of develop-

ment. A first hand acquaintance will be gained with the more familiar types, and the foundation laid for taking up a more detailed study of the different groups of invertebrate animals. Woods "*Elementary Paleontology*" will be used as a text-book, and the English edition of Zittel as a work of reference.

Two recitations and two three-hour laboratory periods per week.

First and Second Semesters, Senior Year, Group III

103, 104. ADVANCED PALEONTOLOGY

This course supplements the instruction offered in Paleontology 1, 2, and aims to give an intimate acquaintance with the structure, relations and geological history of the different groups of invertebrates, more especially those concerning which the field geologist is required to possess a good working knowledge. Students will be expected to do a considerable amount of reading along suggested lines, and may be called upon to prepare a written theme upon an assigned topic. Besides the lectures, reading and laboratory work, opportunity will be afforded during the year to take part in field excursions and collection trips. Grabau and Shimer's *North American Index Fossils* will be used with other standard works of reference.

Courses to suit the needs of the student.

ECONOMIC GEOLOGY

PROFESSOR LEIGHTON

1, 2. ECONOMIC GEOLOGY

Designed to give the student a general idea of the origin, mode of occurrence, distribution and uses of the non-metallic and metallic mineral resources with special reference to the deposits of the United States.

Four recitations per week.

Second and Third Periods, Junior Year, Groups I and III

3. GEOLOGY OF COAL

A study of the United States coal fields, from a geological viewpoint, with brief reference to the foreign fields.

Two recitations per week. First Semester, Senior Year, Group III

4. GEOLOGY OF ORE DEPOSITS

An advanced study of the origin and mode of occurrence of ore deposits.

Two recitations per week. Second Semester, Senior Year, Group III

5, 6. SEMINAR

The current periodicals and new publications are reviewed.
One hour per week.

First and Second Semesters, Senior Year, Group III

107, 108. ADVANCED ECONOMIC GEOLOGY

Courses to suit the needs of individual students desiring special or advanced work.

12, 13. ENGINEERING GEOLOGY

A course designed for civil engineering students and covering in a brief way the subjects of general geology, economic geology and mineralogy, emphasizing the points of practical value to the Engineer.

Two recitations and one three-hour laboratory period per week.

First and Second Semesters.

MINING SURVEYING

PROFESSOR BLACK AND MR. ———

I. SURVEYING—GENERAL COURSE

The course includes:

I. PRELIMINARY SURVEYING. Pacing, ranging; preliminary location of mining claim and filing of notice of location; adjustment of Locke level; topographical survey of mining claim by pacing and hand level.

II. LAND SURVEYING. Adjustment of compass; subdivision of land; farm survey; city survey; adjustment of solar attachments; official survey of mining claim.

III. TOPOGRAPHICAL SURVEYING. Adjustment of transit; repetition traverse; azimuth traverse; adjustment of plane table instrument; topographical survey with plane table; topographical survey with transit and stadia; tying in of topographical survey to triangulation system.

IV. GEODETIC SURVEYING. Measurements of base line; triangulation, including computations and adjustment of quadrilateral; adjustment of engineer's level; determination of elevation of bench marks and triangulation points by levelling; observation on Polaris with transit for determination of true azimuth.

V. RAILROAD SURVEYING. Reconnaissance with clinometer and pocket compass; preliminary survey with transit, chain and engineer's level; topography by pacing and hand level; permanent location with transit, steel tape and engineer's level; computation of simple and compound

curves; setting curve and line stakes with transit and steel tape; profile levelling; plotting on profile sheet and establishment of grade; cross-sectioning; computation of cuts and fills; computing and laying in turnouts, frogs, switches and Y-junction curves.

VI. UNDERGROUND SURVEYING. Underground practice in surveying; carrying the meridian underground by various methods, such as 2-wire, 3-wire, 4-wire, and with auxiliary telescope; survey of secondary openings, recording of survey, use of mine maps, etc. This work is carried on at a mine near Pittsburgh.

Maps are required to be made of the mining claim pacing survey, the mining claim official survey, the azimuth and repetition traverses, the farm survey, the city survey, the stadia survey, and the railroad survey.

The class is divided into squads, each man being required to do every kind of work with every instrument used, make a full set of notes of the work done by his squad, and from those notes make the maps in the drafting room.

Fifty hours per week. First Period, Junior Year, all groups

2. UNDERGROUND SURVEYING

Underground practice in surveying; carrying the meridian underground by various methods, such as 2-wire, 3-wire, 4-wire, and with auxiliary telescope; survey of secondary openings, recording of survey, use of mine maps, etc.

Two lectures or recitations per week for one semester, in addition to a week or ten days in practical underground surveying.

This course is designed for men who enter with advanced standing and receive credit in Mining Surveying I, except Part 6.

3, 4. MINE MAPPING

Making of maps from survey notes; plan, longitudinal and cross-sections of ore mine; plans of anthracite and bituminous coal mines. For the last, the notes made in Mining Surveying I are used.

Three hours per week in the drafting room.

Second and Third Periods, Junior Year, Group I

MINING

DEAN MELLER, PROFESSOR BLACK, DR. WALLGREN AND MR. ZIMMERMAN

The aim of the curriculum in Mining Engineering is to impart such knowledge as will enable the student to carry through a mining enterprise successfully. In order to conduct mining operations intelligently, he will be called upon as an engineer to employ the principles of mathematics, physics and mechanics; the sciences of geology, mineralogy, chemistry and

metallurgy; and the arts of civil, mechanical and electrical engineering. He must also have ability for organization and business management.

The principles, sciences and arts mentioned are taught by specialists in the different departments, their particular application to mining being specially emphasized.

The student is offered lines of election as follows:

The Mining of Ore (Mechanical-Electrical or Management Option).

The Mining of Coal (Mechanical-Electrical or Management Option).

In every case the student receives instruction in the fundamental principles of mining. In case he elects the mechanical-electrical option in either ore mining or coal mining, he is required to take courses during the Senior Year in the application of steam, air and electricity to mining. In the event that he elects the management option, a large part of his Senior Year is spent in the study of problems in the economics of mining, such as confront the mine manager, operator and financial agent.

In connection with the department is a laboratory equipped with the most modern machinery used in underground work, steam, air and electricity being directly available as power.

Class instruction is supplemented, where possible, by visits to mines in the vicinity; by reference to mine maps, models, drawings and descriptions of plants, etc.

I. PRINCIPLES OF MINING

PROFESSOR BLACK

A shorter course for those not specializing in Mining.

Includes:

Prospecting—Aids, methods, outfits, etc.

Boring—Purposes; percussive boring, rotary boring; survey of bore holes.

Placer Mining—Prospecting and developing; sluicing, hydraulicking, dredging.

Rock Drills—Hand drills; power drills—steam, air and electric.

Explosives—Types, care and use.

Method of entry—Adit, drift, slope, shaft.

Shaft Sinking and Tunnelling.

Support of Excavations—Pillars of ore or coal, broken ore, timber, masonry, brickwork, metal.

Methods of Mining—Ore; coal; stone; etc.

Coal Mining Machinery—Pick machines; chain cutters; etc.

Mine Gases and Ventilation.

Lighting—Candles; torches; lamps—Oil, acetylene, electric.

Haulage—Railways; aerial tramways; etc.

Hoisting—Hoists: steam, air and electric; drums; ropes; skips; cages; etc. Balanced hoisting.

Drainage—Surface and mine. Mine pumps; water hoisting.

Surface Plant—Shaft house; tippie; power house; magazine; store-houses; lamp-house; arrangements for surface transportation; etc. General arrangements for different types of mines.

Accidents—Explosions; fires; falls—their cause and prevention.

Sociology—"Safety First"; mine labor; welfare work; etc.

Visits of inspection are made to working mines in order that the students may become familiar with the practical application of the principles discussed in the class-room. (See Inspection 1, 2, 3, page 50).

Three recitations per week.

First Semester, Senior Year, Groups II and III

3, 4, 5, 6. PRACTICE OF MINING (General)

DEAN MELLER

These courses cover the same outline as Course 1, but each of the subjects is treated in more detail, and from the standpoint of the engineer directly interested in mining operations. They are intended for the prospective mining engineer, who desires a comprehensive treatment of all branches of mining. Methods of mining iron, copper, gold, silver, lead, zinc and other ores are studied in detail. Numerous mathematical and other problems, similar to those met in actual engineering practice are introduced, in order to apply the principles covered in the several courses. Special emphasis is laid on the most recent practice, for which reference is made to current periodicals. Working mines in Pennsylvania and adjacent states are used for the purpose of illustration thruout the courses. See Inspection, page 50.

Three lectures or recitations per week. Second and Third Periods, Junior Year; First and Second Semesters, Senior Year, Group 1-a.

7, 8, 9, 10. PRACTICE OF MINING (Coal)

PROFESSOR BLACK

These courses are similar in plan and scope to those described under Practice of Mining (General), but devote most of the time to coal mining

methods and the direct application of the several subjects in the outline to coal mining. Mine Gases, Ventilation, Lighting and Mining Machinery are treated in detail, thus meeting the special needs of students having a definite preference for coal mining.

Three lectures or recitations per week. Second and Third Periods, Junior Year; First and Second Semesters, Senior Year, Group I-b.

11, 12. MINING MACHINERY—STEAM AND AIR

PROFESSOR BLACK

This course covers mining machinery operated by steam or compressed air power. Such equipment for haulage, hoisting, drainage, ventilation, rock drilling, coal cutting and exploration is studied in detail and operated. Various tests are made, including that for efficiency. Mine power plant is considered. Mines are visited at intervals during the course in order to study machinery under working conditions.

Two lectures or recitations and one three-hour laboratory period per week.

First and Second Semesters, Senior Year, Group I (Mechanical-Electrical Option).

ELECTRICITY APPLIED TO MINING. See E. E. 27, 28, page 29.

14. MINE PLANT DESIGN

DEAN MELLER AND PROFESSOR BLACK

Design of surface structures, such as head-frame, ore-bins, tippie, boiler-house, etc.

Six hours in the drafting room per week.

Second Semester, Senior Year, Group I.

15, 16 MINE COSTS, MANAGEMENT, AND VALUATION

DEAN MELLER

This course covers: Considerations which should precede the opening of mines, as topography, labor conditions, climate, transportation facilities, etc.; incorporation and capitalization; promotion of mining and exploration companies; investments in mines and mining stocks; reasons for failures in mining; mine administration; details of costs for operation, maintenance, depreciation and amortization, etc. Following this is a study of mining costs of representative companies in the various mining fields of the world.

The course concludes with a study of the factors which assist the engineer in determining the value of a producing mine or a prospect; conduct of the examination; report, etc.

Three lectures or recitations per week. First and Second Semesters, Senior Year, Group I (Management Option).

17. MINING LAW

DEAN MELLER AND PROFESSOR BLACK

A study of the Revised Statutes and subsequent Acts of Congress governing mining in the United States; State mining laws with especial reference to those of Pennsylvania.

Two lectures or recitations per week. First Semester, Senior Year, Groups I and III.

18. FIRST AID AND MINE RESCUE WORK

PROFESSOR BLACK AND DR. WALLGREN

This course includes instruction in the following subjects: Bruises, sprains, fractures, shock, burns, and gas poisoning, etc.; principles, design and use of the helmet and mouth-breathing devices, resuscitation apparatus, and in the methods of mine rescue work.

Three laboratory hours per week. Second half of Second Semester, Senior Year, Groups I and IV.

19, 20. MINING LABORATORY.

PROFESSOR BLACK

201, 202. ADVANCED MINING

DEAN MELLER AND PROFESSOR BLACK

Intended to afford advanced and graduate students an opportunity to continue the study of mining for a post-graduate degree.

Arranged to suit the needs of the individual student.

METALLURGY.

PROFESSORS GOODALE AND RAY AND MR. BROWN

1, 2. GENERAL METALLURGY

PROFESSOR RAY

A general course covering the extraction of the common metals from their ores, and the properties of metals, of refractory materials and of the usual metallurgical products and supplies. The first semester laboratory will be mostly taken up by assaying and its application in metallurgical control.

Two recitations per week, First and Second Semesters; two laboratory periods, First Semester; one laboratory period, first half of Second Semester. Senior Year, Groups I and III.

3, 4. GENERAL METALLURGICAL PRINCIPLES

PROFESSOR GOODALE

This course comprises a study of metals, alloys, metallurgical materials, products and general operations, fuels, furnaces, measurements, etc.

Three recitations and two laboratory periods, Second and Third Periods, Junior Year, Group II.

5, 6. THE BLAST FURNACE

PROFESSOR GOODALE

A detail study of the construction and operation of the blast furnace and its accessories. Several excursions to furnaces are made during the laboratory periods. The course includes also a study of pig iron.

Four recitations and two laboratory periods, Second and Third Periods, Junior Year, Group II-b.

7, 8. THE MANUFACTURE OF STEEL

PROFESSOR GOODALE

A detail study of the construction and operation of the various furnaces and accessory apparatus used in the refining of pig iron and manufacture of finished steel. A number of visits to neighboring plants are made during the laboratory periods.

These two courses, together with numbers 5 and 6 are intended to cover, with as great care as possible in an undergraduate course, all phases of the metallurgy of iron and steel.

Four recitations and two laboratory periods, First and Second Semesters, Senior Year, Group II-b.

9, 10. METALLURGICAL CALCULATIONS

PROFESSOR GOODALE

A study of the calculations relating to quantities of heat and material and costs involved in furnace and other operations of metallurgy. The subject of proportioning furnaces and other apparatus is also taken up. In the second semester the class is divided into one section for general metallurgy and one for iron and steel.

Three recitations, First Semester; two recitations, Second Semester, Senior Year, Group II.

11, 12. COPPER, LEAD, THE MINOR METALS

PROFESSORS GOODALE AND RAY

These courses are intended to give a thoro knowledge of the metallurgy of copper, lead and other common metals. These courses cover the same field as numbers 1, 2, but in a more advanced manner.

Four recitations and two laboratory periods, First and Second Semesters, Senior Year, Groups II-a and II-c.

13, 14. ELECTRO-METALLURGY

PROFESSOR GOODALE AND MR. BROWN

A careful study of the electrothermic and electrolytic methods and processes applied to the recovery and refining of metals. The course takes up some of the most interesting phases of metallurgy.

Two recitations and two laboratory periods, First and Second Semesters, Senior Year, Group II.

16. GOLD AND SILVER

PROFESSOR RAY

This course covers the metallurgy of gold and silver with special reference to the hydrometallurgy or leaching processes, such as cyanidation - the most important -, chlorination, etc. The cyanide process is treated in detail on account of its present and growing importance. The refining of bullion by different methods is thoroly treated.

Two recitations and two laboratory periods, Second Semester, Senior Year, Groups II-b and II-c.

17, 18. FIRE ASSAYING

PROFESSOR RAY

These courses are for any special or advanced students who desire to study this subject. Fire Assaying is required in Groups I and III, and is included as a part of the laboratory exercises of courses 1, 2 in the Senior Year. To Group II students it is given in Junior Year with Met. 3.

The course is designed to give the student a thoro theoretical and practical knowledge of the assaying of ores of gold, silver and platinum by fire methods. Commercial laboratory methods, giving speed of manipulation, are taught, as well as more refined methods for special accuracy.

Elective Course. Two laboratory periods, First and Second Semesters.

19, 20. METALLOGRAPHY

PROFESSOR GOODALE

A study of metals and alloys, their structure, properties, etc. Work with the microscope, physical testing, photo-micrography, etc. Much of the substance of this course is included in the courses on iron and steel for students in Group II-b.

Elective course. One recitation and two laboratory periods, First and Second Semesters.

221, 222. ADVANCED METALLURGY

PROFESSORS GOODALE AND RAY

It is desired to give advanced students an opportunity to pursue their study in metallurgy for a postgraduate degree. The work is carried on in each case as the occasion seems to require, to give each student the greatest advantage from his work.

Courses to suit the needs of the student.

ORE DRESSING

PROFESSOR RAY

Ore Dressing is the study of the applications of physical laws to those mechanical processes and apparatus which have as an object the breaking of ores and the concentration of valuable minerals, whether metallic or non-metallic. It also involves the study of the apparatus used, its design and arrangement in the plant.

1, 2. GENERAL ORE DRESSING

A general course dealing with the principles and practice of dressing of ores and coal, designed for the general metallurgical or mining student. It includes the object and principles of ore dressing; stamp milling, followed by amalgamation and concentration; description of the construction and operation of the principal types of crushers, stamps, classifiers, concentrating devices and accessories. Classroom work is aided by models, slides and laboratory apparatus.

Two recitations, First and Second Semesters; one laboratory period, Second Semester. Senior Year, Groups I and III.

3, 4. INTRODUCTORY ORE DRESSING

The introductory course designed especially for those students who intend to follow ore dressing, or those lines of metallurgy where ore

dressings is used. It deals with the same subjects as Ore 1, 2, but is more advanced, especially in the study of the principles and theory.

Four recitations, Second and Third Periods; two laboratory periods, Third Period, Junior Year, Groups II-a and II-c

5, 6. ADVANCED ORE DRESSING

An advanced course for those students who wish to enter this field as operators or designers. It makes a detailed study of the apparatus from a mechanical point of view, and treats more in detail certain processes, as electro-magnetic and electrostatic separation, flotation and slime treatment. Also discusses the economic phases of the subject. The laboratory work of the Second Semester will include design of ore dressing machinery and plants.

Four recitations First Semester; two recitations Second Semester; four laboratory periods, First and Second Semesters. Senior Year, Group II-c

8. COAL WASHING

A course to replace Ore 6 in above sequence. For those students making a specialty of coal treatment. Hours same as Ore 6.

109, 110. ADVANCED WORK IN ORE DRESSING

This offers an opportunity for advanced and graduate students to follow some particular line of investigation. The courses will be conducted by reading and laboratory work in consultation with the instructor.

Arranged to suit the needs of the student.

OIL AND GAS PRODUCTION

PROFESSOR JOHNSON AND MR. HUNTLEY

The courses in oil and gas are planned to equip men to (a) determine the relative chances of success in finding oil and gas by drilling at different points; (b) methods by which wells are most efficiently spaced, drilled and operated; (c) methods by which the business of oil and gas production is transacted. So much of the oil and gas industry is carried on by crude and inefficient methods that a technical training in these lines greatly increases the efficiency of the worker as compared with the usual training by imitation alone. The practice in the summers is an important part of the work. In the first and second summers the student ordinarily works on an oil lease; in the third he will work as a geologic aid on the Federal or a State Survey, or again on prospective or developed properties.

There are two courses—one leading to specialization in prospecting, the geological option, and the other leading to specialization in operation. The second may be modified further by those specializing in the business aspects of the oil industry. Students desiring to specialize in petroleum refining, see courses outlined under Chemical Engineering.

1. GEOLOGY OF OIL AND GAS

PROFESSOR JOHNSON

Origin, accumulation and occurrence of oil and gas. Methods of determining chances of success in locating oil and gas wells.

Four lectures or recitations per week. Second Period, Junior Year, Groups III and IV.

2. COMPARATIVE OIL FIELDS

PROFESSOR JOHNSON AND MR. HUNTLEY

Oil and gas fields and promising untested regions of the United States.

Four lectures or recitations per week. Third Period, Junior Year, Groups III and IV.

4. FOREIGN OIL FIELDS

MR. HUNTLEY

Canadian, Mexican and South American oil fields and promising untested regions. A shorter discussion of other foreign fields.

Two lectures per week.

Third Period, Junior Year, Group IV

5. THE BUSINESS OF OIL AND GAS PRODUCTION

PROFESSOR JOHNSON

Leasing, organization of companies, methods of co-operation in drilling tests and offsetting, operation on public lands, drilling contracts, etc. History, leading Companies.

Two lectures or recitations per week. First Semester, Senior Year, Group IV,

6. THE TECHNOLOGY OF OIL AND GAS PRODUCTION

PROFESSOR JOHNSON

Spacing of wells, drilling, pumping, transportation and storage. Increasing the percentage of recovery. Gasolene from gas. Distribution of gas.

Two lectures or recitations per week, Second Semester, Senior Year, Group IV.

8. APPRAISAL AND REPORTS OF OIL AND GAS PROPERTIES

PROFESSOR JOHNSON

Methods by which the value of oil and gas properties is determined. The methods of examination and of making reports upon properties.

Two lectures or recitations per week, Second Semester, Senior Year, Group IV.

9, 10. OIL AND GAS LABORATORY

PROFESSOR JOHNSON

Exercises and investigations with oil field maps, geological maps, statistics, records of companies, etc., in the geology of oil and gas. Experimental work in the laboratory on the roles of porosity, capillarity, viscosity, immiscibility, movement, pressure, quality of oil, heat, etc., on the theory of the accumulation of oil and on the problem of its most efficient extraction. The work is partly individual and original. To accompany 1 and 2. Second and Third Periods, Junior Year, Group IV.

11, 12. ADVANCED OIL AND GAS LABORATORY

PROFESSOR JOHNSON

A continuation of the work above, in the following year. First and Second Semesters, Senior Year, Group IV.

14. EXAMINATION OF AN OIL OR GAS PROPERTY

PROFESSOR JOHNSON AND MR. HUNTLEY

The actual examination and preparation of a report of an oil or gas property.

Five hours field and laboratory per week, Second Semester, Senior Year, Group IV.

15, 16. SEMINAR IN OIL AND GAS

PROFESSOR JOHNSTON AND MR. HUNTLEY

A seminar for the study of current development and progress. The current periodicals and reports are reviewed. New data exhibited. The current statistics are plotted graphically by the several students.

One hour per week, Second and Third Periods, Junior Year, Group IV.

17, 18. SEMINAR IN OIL AND GAS—CONTINUED.

PROFESSOR JOHNSON AND MR. HUNTLEY

One hour per week, First and Second Semesters, Senior Year, Group IV.

INSPECTION

1, 2.

Visits of inspection are made on alternate Mondays to mines, mills, furnaces, oil wells, etc. In each case a written report is required.

Second and Third Periods, Junior Year.

3, 4.

A continuation of Inspection 1, 2.

Alternate Mondays, Fall, Winter and Spring Terms.

Intended for Seniors, and more complete reports are required.

6.

At the conclusion of the work of the Senior Year a period of three weeks is allowed for a field trip, which will be required of all students in the Mining, Metallurgical and Geological Groups, except those who, in the opinion of the faculty shall have had a sufficient amount and variety of experience to warrant their being excused. No fee is charged for this course, but each student must bear his own expenses.

Three separate trips have been arranged, to alternate.

(1) Eastern Pennsylvania and New York.

(2) Michigan iron and copper country.

(3) Southern coal, iron and copper fields.

The localities visited afford opportunity for advanced work in mining, metallurgy and geology. Special work is assigned to each student, and he is required to keep a careful record of his observations and investigations. At the end of the trip, a complete report, with sketches is required. All work is done under the supervision of instructors from the school.

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UNIVERSITY OF PITTSBURGH

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